BIELEFELD UNIVERSITY

DISSERTATION / DOCTORAL THESIS

ESSAYS ON LABOR ECONOMICS AND INTERNATIONAL TRADE

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A thesis submitted for the degree of Doctor of Philosophy (Ph.D) in Economics

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June 2019

Chapter 1.
The Heterogeneous Effects of Violence on Individuals Labor Market Outcomes: an evidence from Mexico

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Abstract

While, most of the literature, studying the Mexico's drug related violence, focus either on explaining the causes behind the dramatic increase in the homicide rate or analyzing the effect of crime on aggregated economic variables. This paper studies the effect of increasing violence over individual's labor market outcomes in Mexico, by combining rich individual-level data that enables to compare the labor market outcomes for the same worker before and during high levels of violence in Mexico. This study finds an heterogenous effect of incresing violence over the labor outcomes of individuals in high and low income groups, rather than by gender. The surge in the Mexico homicide rate, represent a negative shock for low-income individuals, since they are affected in a greater extent by violence than individuals in the high-income group, sharpening problems of inequality and poverty for people living in municipalities where the violence have escalated. Moreover, we find evidence to argue that there is a disproportionitated effect of incresing violence between blue-collar, unskilled and white-collar, skilled workers. Whereas, for workers performing in high-skill occupations the effect of higthened violence have caused a slight increase on their labor outcomes. For workers in low-skill occupations as agriculture and personal services, caused a decline in their income. Excepting for workers in occupation related to safety and security, where the probability of beign employed and the number of hours worked weekly have increased. These finding are robust to taking into account the endogeneity of violence, by using geographical and drug supply in Mexico as identifying instruments and after controlling for endogenous migration within our sample.

JEL Classification: *J01 J30, O54, R23*

Keywords: *Homicide Rate, Labor Market Outcomes, Labor Market Participation, Monthly Income, Annual Income, Municipality, Drug Trafficking Organizations.*

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I. Introduction

Violence and crime involve high economic costs on affected populations. In developing countries, these acts sharpens latent problems of poverty, unemployment, low economic grow, low investment and low educational attainment rate. The literature studying the impact of violence on socio-economic outcomes at the individual and household level, has grown in the last decade, since violence is a persistent social issue in many developing economies (Kondylis, 2010; Bozzoli et al., 2013; Shemyakina, 2011). Specially, in Latin American countries, one of the main sources of violence historically have been related to the drug trafficking.

In the last 20 years, the drug trafficking activity in Mexico have evolved to become in one of the world's largest and most sophisticated drug networks. In Mexico, drug-related organized crime groups, in order to increase their profits and influence, have been fighting one another for territorial control and traffic routes, even in some areas of the country, they might possess greater coercive force and governance capabilities than the legit local governments. In 2006, the former Mexican President Felipe Calderon launched an initiative to decisively combat the cartels using military force. These actions significantly unfolded an unprecedented escalation of violence, claiming thousands of lives, including many civilians. Living under such dramatic high levels of violence, surely has an impact on people's economic outcomes.

The recent crime increase in Mexico has motived a growing research on this topic and its impact on many aspects of Mexican population, such as: education attainment, migration, physical and mental health conditions, among others. However, there are relatively few papers that have looked at the effect of crime derived from the increasing drug-related violence on the main individual-level labor market outcomes in detail, as is the aim of this paper.

The contribution of this paper can be expressed in following three aspects.

First, it investigates the effect on labor market outcomes of individuals living in a environment of relative normal levels of violence and the subsequent exponential increasing in the violence intensity. While, most of the recent literature, studying the

Mexico's drug related violence surge, as the works of (Dell, 2015; Dıaz-Cayeros et al., 2011; Castillo et al., 2014), are studies either focusing on explaining the causes behind the dramatic increase in Mexico's homicide rate or analyzing the effect of crime on aggregate economic variables for cities and the whole country, rather than its economic impact on individuals' economic conditions. Moreover, previous papers by Velásquez (2010) and BenYishay and Pearlman (2013), only present one part of the story, the first one, shows that increasing homicides rate in Mexico are negatively correlated with the earnings and labor market participation of self-employed men. Whereas the latter one, assesses the impact of violence in Mexico just in the amount of worked hours among the all working-age population.

Second, in the empirical analysis we acknowledge the possible endogeneity explained by the correlation between the level and evolution of violence over time and the individual labor market outcomes obtain from a local labor market as the municipality of residence. Such reverse causality problem emerges directly due fact that, municipalities with better economic opportunities attract higher levels of crime and municipalities located closer to U.S border might suffer higher levels of violence because confrontations between Drug Trafficking Organizations (DTO's) can be more noticeable and persistent in the border area. To accurately identify causal effects of increasing crime in individual labor market outcomes and to adequately control for these issues, we incorporate into the analysis an instrumental variables approach. By exploiting the temporal variation of cocaine supply in Mexico and the geographical location variations of municipalities, we define an instrument, which considers the interaction between seizures of cocaine in Colombia and the nearest distance to the U.S. border for each municipality. Using this approach we will able to separate the variation of violence from factors that could affect homicide rates and the economic activity, as well as, from the economic variations that could affect homicides rates. Getting as results unbiased estimations of the effect of violence at individual-level labor outcomes.

Third, by using the Mexican Family Life Survey (MxFLS), a longitudinal survey containing 8,440 households across 150 communities in Mexico, being both nationally and regionally representative, containing extensive economic and demographic information at the household and individual level. Given that, the information was collected in 2005 and 2009, coinciding with the period when the homicide rate in Mexico sharply increased, we are able to compare the labor market outcomes for each single person at MxFLS before and during high levels of violence. Moreover, exploiting the richnesses at MxFLS, we explore the heterogeneity of the results obtained, by defining different subgroups within population, this allows us to provide a complete and revealing evidence regarding how the effect of violence is spread among population.

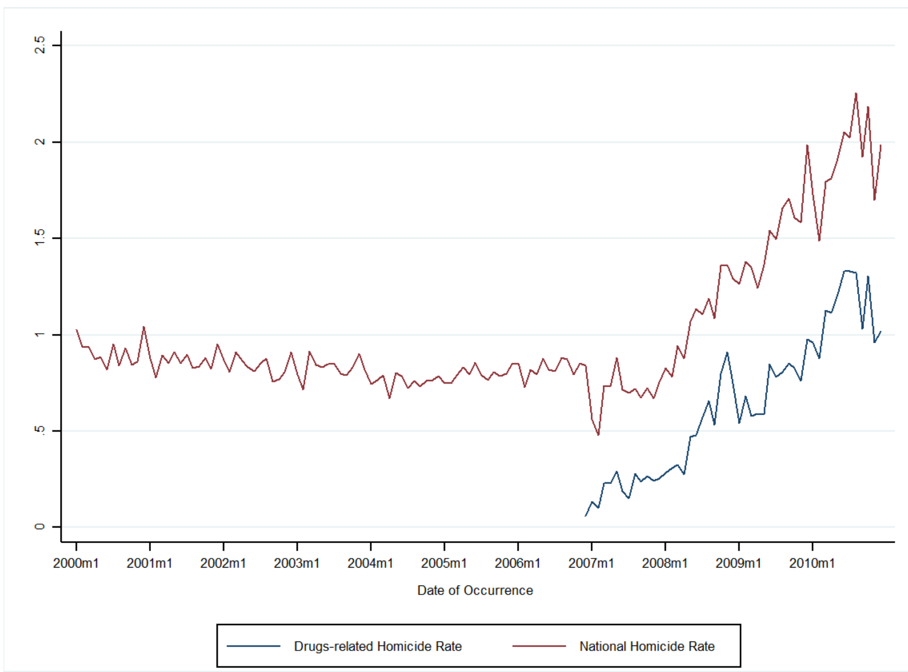
Our findings suggest that, the labor market participation, the probability of being employed, monthly wage income and the total monthly income, for an average person had been negatively affected by the increasing levels of violence in Mexico. Moreover, comparing our results among individuals in high and low income groups, we find that the surge in the Mexico homicide rate, represent a negative shock for low-income individuals, since they are affected in a greater extent by violence than individuals in the high-income group, sharpening the problems of inequality and poverty for people living in municipalities where the violence have escalated. Moreover, we find a disproportionated impact of crime between different types of workers. While, increasing violence in Mexico, represents a negative shock among blue-collar, unskilled workers. Labor market outcomes among white-collar, skilled workers have increased.

This paper continues as follows: next section provides a description of the increase in the homicide rate observed in Mexico since 2007, as well as, the potential explanations given by the related literature. Section III, describes the data used in this study, specially we analyzed whether migration is a important issue driving the results, this analysis indeed, allow us to rule out that possibility. Section IV, explains the methodological approach used to identify causal effects of crime on individual labor market outcomes. Section V, presents the results and its heterogeneity for different groups of individuals and workers in different occupations. Finally, in section VI, we give the conclusions and policy recommendations.

II. Drug Related Violence in Mexico an Overhaul.

During the last 10 years Mexico have experienced an increasing incidence of drug related crime and conflict between organized crime groups, spreading across its all territory, attracting a great deal of government, international and public attention. It is estimated that around 170.000 drug-trafficking-related deaths have been registered since 2006 in Mexico. The vast majority of these deaths were caused by confrontations between Drug Trafficking Organizations competing for control of routes and strategic locations for the traffic of drugs on the way to U.S.

Figure 1: *Monthly National and Drug-related Homicide Rates (per 100,000 inhabitants) in Mexico*



Source: Author's own calculation. Data comes from INEGI and Mexican Government

Based on the current literature studying the causes and consequences of higher crime rate in Mexico, we can argue that violence in Mexico has dramatically intensified due to three main factors. First, the militarized fight against drugs and drug trafficking cartels. President Calderon introduced a leadership strategy focus on targeting to arrest the highest levels or core leadership of criminal networks. (Calderón et al., 2015; Dell, 2015;

Guerrero-Gutiérrez, 2011). Second, the increased fragmentation of drug cartels. President Calderon's policies showed not only that were unable to neutralize the DTOs but also that its effects stemming from arresting or killing the leaders of many drug cartels triggered the sharp increase in the number of homicides caused by the increasing confrontation among cartels, fighting to secure the drug trafficking routes towards U.S territory. Third, by the exogenous changes in the international narcotics market. Castillo et al. (2014), argue that, the surge in the drug-related violence in Mexico since 2006 was a consequence of the scarcity in cocaine supply resulting from the increasing drug seizures in Colombia.

As figure 1 shows, we suggests that the increased incidence of organized crime has a direct effect on overall violence and crime, as long as the DTOs diversify their financial source committing others crimes that directly affected the civil population, such as extortions, kidnappings and executions, in fact executions became more frequently targeted at civilians, particularly at authorities, journalist, public employees, and all those that refuse to pay extortion fees. In consequence, drug-related violence became embedded in society and triggered fear among the population in Mexico (Dıaz-Cayeros et al., 2011). In this sense, high incidence of organized crime in a particular area not only affects those involved in these activities but also the population living in these areas.

It is important to mention that while violence has risen consistently over time, there is a great deal of variation in the changes in homicide rates across municipalities. Between 2005 and 2009, on average there was a 0.8 per 10,000 increase in the municipality homicide rates, but some areas suffered a 13 per 10,000 increase while others had a 14 per 10,000 decline. We exploit both temporal and spatial variation to identify the effect of exposure to violent crime on individuals labor outcomes.

III. Data

The dataset that we used in this paper, was built by matching the INEGI monthly homicides reports at municipality level, with the Mexican Family Life Survey. The INEGI data, contains all the officials reports of intentional homicides by occurrence date at municipality level. Then we use the number of homicides to construct the homicide rate per 100.000 inhabitants for each Mexican municipality as a measure of violence at the municipality level. We acknowledge that, others types of crime have also increased as a results of the Mexican drug war. The reason why, this paper and many others conflict studies focus on homicides as a measure of violence is because are less sensitive to systemic misreporting and represent the most accurate proxy to measure the overall crime environment.

In order to study the impact of crime on economic outcomes at individual level, we match the homicides rate data with the Mexican Family Life Survey (MxFLS), which is a longitudinal, multi-thematic survey representative of the Mexican population at the national, urban, rural and regional level. The advantages of use this rich data for the purpose of this study are the followings: First, the MxFLS traces most of households for three periods: 2002, 2005-06 and 2009-10. Which coincides with the prior and after stages of the violence shock in Mexico. Moreover, The MxFLS 1, includes information on 8,440 households and 35,600 individuals among 150 communities in 16 states throughout Mexico. Third, The MxFLS 2, has kept low levels of attrition. Over 89% of the panel respondents were re-interviewed in MxFLS II. Four, The MxFLS 3 was largely conducted in 2009 and 2010, during the dramatic escalation of violence, for this round 87% of the panel respondents were recontacted.

Second, the MxFLS has a rich set of characteristics about the surveyed individuals, including information about the economic, social and health status of each member of a surveyed household. The questionnaire for adults includes sections on education, labor supply, earnings, migration history, marriage history, fertility history and health status.

We focus on the MxFLS 2 and MxFLS 3 because we are interested in the sample of individual of working age and we do not want to exclude the youngest cohort from our study, as their labor market information would not be available in 2002, by doing so, we can look at the impact of crime including the youngest working age individuals. Furthermore, by combining the last two MxFLS waves, we will be able to compare the outcomes of the same individual under different levels of violence, which will allow us to control for all unobserved time-invariant heterogeneity that might be correlated with exposure to violence and household income.

Third, in MxFLS 3 there has been a particular effort on following migrants within Mexico and to the U.S. This is particularly important for this study because migration may be a behavioral response to crime. If individuals, particularly affected by high levels of violence, migrate away from their original municipalities as a response to the increasing crime and they are not tracked, the estimations of the impact of crime on labor outcomes would be biased. Moreover, if migration is due to unobserved characteristics correlated with labor market outcomes and related to violence, this fact may represent a problem for the validity of our results.

The goal of this paper is to investigate the impact of the increased incidence of crime on various labor market outcomes in Mexico, such as labor market participation, probability of being employed, number of working hours. The employment status was define based on the question "What was your main activity last week" on MxFLS, which ask for the labor status at the interview time. The labor market participation variable is a dummy variable indicating 1 whether the individual answered "worked" or "looking for a Job" or were in "Vacations" but have a job and 0 otherwise. The variable Employed, is a dummy variable indicating 1, whether the individual answered "worked" and 0 otherwise. It does not refer to any specific type of employment. Moreover we consider as well several income related variables, mainly split in Labor-wage income as: Monthly and Annual wage Income and total monthly income accounting for any source of income, regardless the earnings are coming from a payroll or are obtained by their own means .

The main challenge to estimating the impact of crime on labor outcomes is the problem of identification associated with potential reverse causality and omitted variable bias. The level of violence and its change over time are not random across municipalities or independent of other factors that may affect labor outcomes. The reverse causality problem comes out from the fact that, municipalities with better economic opportunities attract higher crime. Since, violence has a negative effect on economic activities and unemployment, causing poor economic performance or high unemployment rates, it might also generate more violence. One strength of our empirical approach is to solve these concerns and be capable to get unbiased estimations identifying the casual effects of crime on individuals labor outcomes.

Moreover, to shield our results from the bias derived from endogenous migration patterns, we estimated the relationship between migration and the exposure to crime. We examine whether individuals living in a certain municipality in 2005 that have experienced an increase in the homicide rate by 2009 are more likely to migrate to safer cities. We also need to included some controls accounting for the individuals and households characteristics reported in MxFLS 2, to identify whether the characteristics of these movers are significantly different from non-movers. To address the endogenous migration analysis, we use the following specification.

$$Mig_{ij} = \alpha + \rho \Delta Cr_j + \beta' X_i + \theta St_{05} + u_{ij} \tag{1}$$

Where Mig_{ij} is a dummy variable indicating whether the individual i living in the municipality j at the time of MxFLS 2, moved to a different municipality in MxFLS 3, ΔCr_j is the homicide rate change between 2005 and 2009 in municipality j , X_i is the vector of individuals and household characteristics measured in MxFLS 2, (marital status, age, school attainment, household seize, work experience, number of children, number of kids, babies) and the St_{05} represent the state fixed effects for the initial state of resident. Specifically, exposure intensity to crime for individual i will be assigned based on the municipality j where she or he was living in 2005, rather than their current municipality of residence. By fixing the respondent to their 2005 municipality of residence prior to the sharp increase in the homicide rate, any migration caused or correlated with change in the crime level will not impact their assigned violence exposure level, this reduces concerns about the potential situation in which migration behavior is driving the results.

The results obtained from estimating the equation (1), are presented in table 1, the results suggest the following: First, for our example the migration decision was not driven by the change in the homicide rate, which mean that migration is not endogenous. Second, it support the assumption that an individuals followed in 2005 and 2009 remained in the same local labor market. Third, the amount of those individuals who eventually moved is not statistically significant to undermine the results validity for the labor market outcomes. In addition, the low magnitude of those individual and household characteristics that seems to exert an impact on the migration decision allows us to argue that there is not difference between the individuals characteristic among the responders that migrated and those who remained living in the same municipality.

IV. Empirical Strategy, Identifying causal effects

To reduce concerns about the omitted bias problem that naturally arises in studies about crime and labor market outcomes, first we employ a within individuals analysis and then we will introduce a new instrumental variable that will allow us to identify real causal effects on how crime expansions might affect the adults labor opportunities and their income outcomes. Consistent results using the IV method will indicate that neither endogeneity nor unobserved variables drive our results. Furthermore, by making comparisons for the same individual over time, we can control time-invariant characteristics and given the data availability at MxFLS, we can also control for time variant household and individuals characteristics . Our empirical strategy can be generalized in the following regression framework:

$$y_{ijt} = \alpha Cr_{jt} + \beta_l X_{it} + \gamma_l M_{jt} + \theta_i + u_{ijt} \tag{2}$$

Where y is the outcome of interest of individual i living in municipality j in year t, Cr is the homicides rates at the municipality level in time t, X is a vector of individual characteristics (age, education level, marital status, household size, working experience, number of children), θ_i captures individual fixed effects, the term M_{jt} refers the set of time-variant municipalities features, such as the number of economic units, percentage of houses with energy connection and the municipality gross output per-worker, that are taken into account to capture the economic and social development extent of each municipality.

One of the main difficulties to estimating the impact of crime on labor market outcomes is the potential reverse causality and omitted variable bias. Identifying the effect of crime on labor outcomes, present an reverse causality problem because the level of violence and its change over time are not random across municipalities nor independent of other factors that may affect labor outcomes, meaning that municipalities with better economic opportunities may attract higher crime. Implying that homicides rates might not be orthogonal to unobserved factors that influence the municipality economic performance. Moreover, since we are interesting in analyze individual-level labor outcomes, the correlation between the independent variables with unobserved characteristics could be explained by self-selection. $E[\theta_i, X] \neq 0$

Therefore, is reasonable to consider that u_{ijt} is correlated with Cr_{jt}, because crime might be higher in municipalities with a better economic performance, where the labor market outcomes may be larger. As we know, a simple fixed effect transformation of equation (2) generally results in inconsistent estimations of all coefficients, because in this case we have that $Cov[Cr_{jt}, u_{ijt}] \neq 0$

To identify causal effects, we need to address the potential reverse causality, to do so, we exploit the following facts: First, large seizures of cocaine in Colombia since 2002, brought a drop in the supply and an increase in the international price for drugs, as consequence, violence among Mexican cartels increased as a response to the drugs scarcity, Castillo et al. (2014)[1]. Specifically, this effect follows, holding the assumption that cocaine shortages increase revenue for drug dealers, which is theoretically the case, so long as the demand for cocaine is inelastic, as the existing evidence suggests. At the same time, increasing revenue to drug trafficking motives armed confrontations among drug cartels, unfolding a heightened violence, see figure 3.

Second, municipalities closer to the US border increased their market value to drug trafficking organizations and precisely has been in these municipalities where violence have increased the most, as competing DTOs fight to gain control over smuggling routes, see figure 4. By exploiting both facts, temporal variation of cocaine supply and geographical location variations of municipalities, we can to construct an instrument, which considers the interaction between seizures of cocaine in Colombia and the nearest distance to the U.S. border for each municipality. Using this approach we will able to separate the variation of violence from factors that could affect homicide rates and the economic activity, as well as, from the economic variations that could affect homicides rates.

[1] According to this study, cocaine production in Colombia went down from about 520 MT per year in 2006 to about 200 MT in 2009, the average price per pure gram of cocaine on US cities streets went up from about \$114 in 2006 to about \$180 in 2009, and the wholesale price went from \$40 to \$68 during the same period

Distance to the nearest U.S. entry point is computed as the distance from the centroid of each municipality to the closest U.S. entry point. The centroids are obtained from INEGI and the entry points from Google Earth. Our variation in scarcity comes from the changes in the supply of Colombian cocaine induced by interdiction efforts. Specifically, monthly cocaine seizures within Colombia. Seizures data comes from the Colombian Ministry of Defense covering the period from 01/1999 to 04/2012.

To be valid our instrument must satisfy two requirements: first, the instrument must be uncorrelated with the error term, $Cov[z, u] = 0$, in other words the instrument must be exogenous, we assume here that, the monthly variation of cocaine seizures in Colombia, cause supply contractions in drug trade-chain markets as Mexico, specially in short periods of time when for DTOs is hard to fill this gap, such variation is exogenous to Mexico, because it only depends on interdiction and funding efforts in Colombia against the locals drug producers and exporting organizations. Second the instrumental variable must be relevant, it must explain our endogenous variable, in our application this requires that our measure of municipality crime rate will partially correlated with the cocaine seizures and distance to U.S border term, but do not lead to change in the labor market outcomes. Formally, if the excludability and relevance conditions are met, then the instrumental variable estimator is a consistent estimator to identify the effect of increasing violence on the individuals labor market outcomes in Mexico.

One additional potential concern to truly identify the effect of crime on labor market outcomes is the Financial Crisis in 2008, which coincides with the MxFLS2 and MxFLS3 waves. If, in the case that, differential municipality experience of the global financial crisis were correlated with the geographic heterogeneity in crime patterns. In the sense that, the economic downturn reduced (heterogeneously across Mexican municipalities) the employment opportunities and the income among adults, leading to an increase in the crime levels within these municipalities. These effects would be hard to split. However, the papers by (Ajzenman et al., 2015; Velásquez, 2010) have explored the relationship between the temporal and geographic variation in violence in Mexico and the heterogeneity in the economic impact of the Financial Crisis directly and found no evidence of a connection. Furthermore including controls for the local economic environment contained in the M_{jt}

and carrying out our estimations including time fixed effects, we address these worries.[2]

V. Results

We begin by examining the first-stage relationship between our instrument and the endogenous variable, the homicide rate. The first stage regression are reduced form regression of the endogenous variables on set of instruments, the relevant test statistic in this procedure is relate to the explanatory power of the excluded instrument. Table 2 contains the result from three models, the first one, a model with the completed controls set that we used to get our main results, the second model including a less substantive control set and the third one which include just municipality and state controls.[3] The results indicate that the interaction term between the cocaine seizures in Colombia and the distance to the US border is a good instrument for the homicide rate in Mexico.

All two coefficients measuring the relationship between these two variables are significant at $p < 0.01$ level. Regarding to the relevance and validity of instruments, the underidentification test, Kleibergen-Paap LM statistic, testing whether the excluded instrument is relevant and the equation is identified, rejected the null hypothesis, indicating that the matrix is full column rank and the model is identified. The weak identification test provide by the Cragg-Donald Wald F statistic, in both models was larger enough to suggest that the instrument performs well. Moreover, the weak-instrument test [4] checking the significance of the endogenous regressors in the structural equation fail to reject the null hypothesis that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and, additionally, the orthogonality conditions are valid.

All the followings tables presents the second-stage results for the IV model in equation

[2] We were cautious in the amount of variables that we considered as local economic controls, since these economic controls might be potentially endogenous in a way that would bias our estimations

[3] We consider the following three groups of controls. Individual characteristics: Education attainment, age, age squared, work experience and marital status. Household characteristics: Household size, number of sons, number of kids (younger than 17 years old), number of babies (children up to 3 years old). municipality characteristics: Number of economic units, share of households with drinkable water access and GDP per-worker.

[4] The Anderson-Rubin Wald test and the Stock-Wright LM S statistic.

(2) as well as some extensions that explore the heterogeneity effect of heightened violence on the adults labor outcomes. Such heterogeneity analysis include interactions between the homicide rate and dummy variables that takes value 1 whether the individual belongs to the followings groups: the first one, young adults group for individuals between 17 and 35 years old. The second one, is the group for age between 36 and 60 years old. Third, for individuals who answered being working as Self-employed.

Furthermore, we complete the heterogeneity analysis considering different income groups and different workers' skill level. In the case of the income groups (High and low income), we estimate quintiles for the total monthly income distribution and based on it, we define the High income group for those individuals at the fifth quintile of the income distribution, in others words, the top 20% of the income distribution. Likewise we define the low income group for those individuals at the first and second quintile of the income distribution. On the other hand, the richness of MxFLS give us to opportunity to categorize the individuals by blue-collar, production and white-collar non-production workers, also distinguished as unskilled and skilled workers respectively, because throughout the three waves it reports the worker position according to the Mexican classification of Occupations.[5] We define two groups, white-collar and blue-collar workers based on their position at work, we consider as white-collar, skilled, worker those individuals belonging to the categories 11, 12, 13, 14, 21, 51, 61, 62, 71.[6] The blue-collar, unskilled, worker group comprise those individuals working in positions classified as 41, 52, 53, 54, 55, 72, 81, 82.[7]

The estimations were clustered by the municipality residence in 2005. The crime measure that we are using here is the average homicide rate over the two years, prior to the month and year of interview.

[5] Full list of Mexican classification of Occupations - INEGI

[6] 11.Professionals, 12.Technicians, 13.Educators, 14.Workers in Art, Shows, and Sports, 21.Officials and Directors in the Public, Private, and Social Sectors, 51.Bosses, Supervisors, etc. in Artistic and Industrial Production and in Repair and Maintenance Activities, 61.Department Heads, Coordinators, and Supervisors in Administrative and Service Activities. 62.Administrative Support Staff, 71.Merchants and Sales Representatives,

[7] 41.Workers in Agriculture, Live stock, Forestry, and Fishing, 52.Artisans and Workers in Production, Repair, and Maintenance, 53.Operators of Fixed Machinery and Equipment for Industrial Production, 54.Assistants, Laborers, etc. in Industrial Production, Repair, and Maintenance, 55.Drivers and Assistant Drivers of Mobile Machinery and Transport Vehicles, 72.Traveling Salespeople and Traveling Salespeople of Services, 81.Workers in the Service Industry, 82.Domestic Workers

i. Labor Market Status Effects

We start analyzing the effects of violent crime on the followings labor market outcomes: labor market participation, employment status and number of working hours.

i.1 Labor Market Participation

The estimation results contained on table 3 (column 1), suggest that, for an average individual, an increased in the local homicide rate lead to a reduction in the likelihood of being participating in the labor market. Specifically, the result suggest that, an individual living in a municipality that had relative low level of homicide rate at the time when he or she was interviewed by MxFLS-2 survey and then experienced the average homicide rate rise over the 24 months prior to the interview by the MxFLS-3, the probability of being participating in the labor market have decreased by 6 percentage points. The results predicts that, an individual who experience one standard deviation increase in the 24 months average homicide rate (13 in 100,000 inhabitants) was 9.6 percentage points less likely to participate in the labor market. Moreover, comparing the results among males and females, we find out, that the increasing violence in Mexico, affected negatively the males probability of being participating in the labor market, such effect might be derive either from victimization threats or because some males quit to work or stop looking for a job; to get involved in criminal activities by joining to drug-related groups. Womens, however, as response are more likely to participate in the labor market, compensating the male absence.

Table 4 shows the analysis of these results among different population groups, specifically, the results are suggesting that, within the females group, those working as self-employed and those females at the first and second quantile of the income distribution, the labor market participation decision is more likely to be negative affected by local crime, due to the fact that these groups of females might be more vulnerable to DTOs confrontations and many others crime expressions, resulting in a high probability of potential victimization while are, working on the streets as self-employed and living in poorer areas.

i.2 Employment

The stream of literature studying the effects of conflicts on firms performance, which usually uses firm-level data for a single country as (Collier and Duponchel, 2013; Pshisva and Suarez, 2010) for instance, argued that armed conflicts affects negatively firms performance, through channels such as transaction costs, investment, expansion opportunities, and firm sales, causing a reduction in the number of employees that a firm hires, this fact would have a negative impact on the probability of being working as employed in a violent environment. Specifically in the case of Mexico, Utar (2018) find a significant negative impact of the surge in violence on plants' output, product scope, employment and capacity utilization. In that sense, we expect a negative impact of increasing violence on workers' employment opportunities, through the negative impact of violence on firms outcomes.

To assess the impact of the Mexican drug war on this labor market outcome, table 5 presents the estimation result based on the IV strategy explained in section IV. The estimate for the non-interacted homicide rate suggest that, for an average individual the likelihood of being employed have been negatively affected by the increasing level of violence in Mexico. Specifically, this estimation suggest that, for an adult person living in a municipality that had suffer a marginal increase in the homicide rate of 1 in 100.000 homicides per habitants, is 3.6 percentage points less likely to currently being employed.

The estimation results showed in columns 9 and 10, describe the effect of Homicide rate over the employed status interacting whether the individual is female or male. The findings suggest an important relationship among females and males employed status, for an average male the increasing violence in Mexico had negatively impacted the likelihood of being working by 2.6 percentage points, whereas for an average female the estimate result is suggesting that such effect is positive, meaning that the likelihood of being employed among females that keep participating in the labor market is increasing a higher violence levels. The combination of these two results, suggest a sort of substitution effect among males and females labor force, in the sense that, in times of heightened violence firms might prefer hire females over males, as a way to keep peaceful and stable workplace environments, moreover, as drug-related violence increases due to cartels confrontations and drug trafficking expansions, males are more likely to enter in cartels groups and get involved in criminal activities, leaving aside the chance of get an employment.

Furthermore, the result in table 6 (column 5), indicate that the effect of violent crime tend to be more significant for individuals located at low levels of the income distributions regardless their gender, the magnitude of such effect is larger for females compared to males, an unit increase (1 in 100.000 inhabitants) in the average homicide rate will reduce the likelihood of being employed for females at the low income group by 1.9 percentage points, while mens belonging to the same group of individuals are 0.6 percentage points less likely to be working as an employee. Additionally, the results suggest that for a blue-collar, unskilled, male worker, a ten unit increase (10 in 100.000 inhabitants) in the average homicide rate will reduce the probability to get a formal job by 4 percentage points, meaning that the drug-related violence in Mexico represents a negative shock on the employment status for those unskilled and low-income male workers.

i.3 Working Hours

A more sensitive measure of how violent crime might affect the local labor market in those municipalities that had suffer sharp increase in the homicide rate, is the total number of hours worked a week, we just considered the logarithm transformation of the number of hours worked weekly in primary jobs. We expect a negative impact of increasing homicide rates on the number of working hours among workers. Specially, intuitively we think that such negative impact might be larger for self-employed individuals relating to other types of workers.

Since, self-employed workers are considered as individuals, who are not remunerated by a salary rather they obtain their income by working on their own business, under their own risk. In developing economies and specially in violent areas within these countries usually, the vast majority of individuals work as self-employment as a survival strategy after being unable to find a formal job. Additionally, due to the fact that, this type of worker develops its daily economy activities mainly on the street, where are more likely to be affected by local criminality. As long as they face victimization threats, self-employers sensitively adjust the amount of working hours by fleeing for their lives or staying at home.

Table 7 provides evidence that homicides negatively impact the amount of hours people work. Such negative effect is predominant among self-employed workers and people located in the low quintiles of the income distribution. Specifically, we find that an increase in 1 per 100.000 inhabitants in the homicide rate, lead to an average decrease in work hours of approximately 6 percentage points, for low-income workers, whereas, the same one 1 unit increase in the homicide rate, will translate in a average decrease of 3 percentage points in the amount of hours worked weekly for self-employed workers.

Moreover, the results contained in table 8 indicate a difference in the heterogeneous respond to homicides between males and females. We find that, for an self-employed woman, an increase in the homicide rate of 1 homicide per 100.000, lead a decrease of 6.3 percentage points in the total number of her working hours. Whereas, for an men who works as self-employed, these effect did not result significant, though it suggested a negative impact. However, column (5) shows, that increasing violence had negatively affected the total number of working hours for low-income males and females, but the magnitude of such negative effect is uneven distributed among females and males, being the former ones who end up more affected. The results are suggesting, for instance, that an increase of 1 per 100.000 in the homicide rate, will reduce the number of total working hours of low-income males by 4.6 percentage points, while for low-income females the negate effect almost doubles going up to 8.5 percentage points. These results suggest that increasing violence can be consider as a negative shock for the number of working hours for low-income individuals and self-employed females. Furthermore, we can imply that low-income females are more sensitive to adjust the number of hours that they work, in environments where violence is rapidly increasing.

ii. Individual Income Effects

Contrary to the large existing literature that assess the economic cost of crime on national income, where (Abadie and Gardeazabal, 2003; Pinotti, 2015; Robles et al., 2013) are prominent examples, in this section we explore the economic impact of violence on Individual-level income variables. The income level of an individual could be affected by increasing levels of violence, if individuals are working less hours during violent times as a mechanism to protect their lives. Moreover, under these violent conditions, workers and business owners might face robberies, extortions, might need to invest in private security and in safety technology, actions that undermine the monthly and annual income, and in other cases businessmen and businesswoman will reach a situation where they have to decide to close their operations.

ii.1 Monthly Wage Income

The results table 9 contained the estimation coefficients of the impact of homicide rate on individuals monthly wage income. The results are suggesting that the increasing violence in Mexico over the 2005-06 to 2009, period does not have a significant impact on the wage income for an average individual, such results comes from the wage rigidity that is naturally embodied in the wage composition. The interesting results comes from comparing the results obtained for low and high income individuals. The coefficient in column 5, suggest that, whereas for an individual located in the quintiles 1 and 2 of the income distribution, the one unit increase in the average homicide rate over the last 24 months prior to the interview date, reduce the log of wage income, by 31.8 percentage points. A very different effect was found for the group of high income individuals, where the logarithm of monthly wage income increased by 7.2 percentage points. Such result for the low-income group, lays out a concordance with those results found for this same population group regarding to the lower probability of being employed and the reduction in the total among of worked hours, the combination of these two effects explain the decrease in the monthly wage income among low-income individuals.

The fact that the effect of crime on the wage income for low and high income groups individuals, goes in opposites directions, means that the drug-related violence in Mexico extended the inequality gap between low and high income communities.

The results in table 10 are confirming the previous results, in this case for both females and males the direction of the effect of violence takes opposites paths regarding the income group, being positive for high income females and males. Specifically, the coefficients in column 4 and 5, suggest that, one unit increase in the homicide rate (1 per 100.000), will reduce the log wage income for females at the low-income group by 23.8 percentage points, whereas the same change in the homicide rate, will increase the logarithm wage income for womens at the high income group by 12.4 percentage points. Moreover, among males, the results indicates that one unit increase in the homicide rate (1 per 100.000), translate in 3 percentage points increase for males in the high income group, and around 34 percentage points decline in low monthly wage income for low-income males workers. These results, also show that within the low-income group, males have been negatively affected in greater extent by drug-related violence than their peers females.

ii.2 Annual Wage Income

The effect of violent crime on individuals annual wage income, presented in table 11, are similar to those found for the monthly wage income case. The estimates results suggest that, the annual wage income has been negatively impacted by the increasing violence in Mexico, among poorer workers and adults at the 36 to 60 years old group. Specifically, the result predicts that for an average worker located at the first and second quantile of the income distribution, an increase of 1 unit in the homicide rate, will cause a reduction of around 30 percentage points in the logarithm of annual wage income. Whereas for an average worker classified at the 36 to 60 years old group, the results indicate that the same change in the homicide rate will reduce the log of annual wage income by 4.5 percentage points.

Moreover, the results by genders, showed at table 12 in column 4 and 5, for mens and womens, we notice that when comparing the results by income level, the finding that, the impact of the wave violence in Mexico during this period have been heterogeneous among different income levels rather than by gender, in the sense that, individuals with low income has been affected by the most, unlike to individuals in the high income group that seems to be increasing their income during violent times.

ii.3 Total Monthly Income

This section studies additional effects of crime on individual labor outcomes during the Mexico drug war expansion. The variable total monthly income here is the logarithm transformation of monthly income for those individuals who are working as a dependent employees and for those who income is derived from their business activity. It was obtained by combining the monthly business income and the monthly earnings at main work, contained at MXFLS database. This variable accounts for any source of income for an specific individual, either from owning a business, working as an employed or the aggregated income obtained from both activities. Although, the estimation results for total monthly income does not distinguish between business owners or salaried workers, by doing so, we are able to extent the analysis of the effects of crime on monetary labor outcomes variables, regardless of the employed status.

The hypothesis follows the one stated in the previous section. The level of earnings might decrease if individuals are working less hours as a mechanism to protect themselves from violence or if the labor demand and private consumption shrinks because firms and families modify their corresponding decisions due to violence or as a response to potential threats, extortions and victimization.

The results in table 13 for all Individuals shows that the differentiated effect of violence among individuals in the low and high income groups persist. While a 1 unit increase in the homicide rate (1 per 100.00) is associated with a 11.6 percentage points increase in the total monthly income for the high income group, the same change in the homicide rate will reduce by around 26 percentage points the total monthly income for an average individual at the low income group.

Furthermore, we find that the increasing violence has a negative effect on monthly total income for blue-collar, unskilled workers and self-employed workers. In particular a one standard deviation increase in the homicide rate (13 per 100.000 inhabitants) will decrease the total monthly income of an average, unskilled worker by 3.12 percentage points and the same change in the homicide rate will decrease by 4.3 percentage points the monthly total income in the case of an average self-employed worker, although the latter one is only at the 10% level of significance.

On the other hand, table 14 presents the analysis of the heterogeneous effects of drug related violence on the total monthly income, by gender within the different socio-economic categories that we have defined previously. The magnitude and direction of the effect of violence on total monthly income, for high and low income groups are similar to those previously described, regardless of gender. Among low income females and males, increasing violence represents a negative impact on their income, contrary to their females and males peers at the high income group, such regularity suggest that an heterogeneous impact of crime over total monthly income is found when comparing different income levels -rich vs poor individuals- rather than among females and males. On the other hand, column 3, suggest that self-employed females have been negative affected by the homicide hike. Since, these type of females might being developing their activity on the streets, or in easily vulnerable working places, without further protection from potential threats. Specifically, one unit increase in the average homicide rate over the last 24 months prior to the interview date, will reduce the total monthly income for self-employed females by 10 percentage points.

iii. Labor Market Outcomes by Occupation

In this section we analyze the heterogeneous effect of heightened violence in Mexico on the labor outcomes of individuals performing in different occupations. The results contained in table 15, show the estimations result of the municipality homicide rate over the last 24 months prior to the date of interview, interacted with an indicating variable that is one if the individuals belong to specific occupation or zero otherwise. We have a total of 17 different occupations sorted following to the Mexican Classification of Occupations (MCO). Such analysis will allows to identify and compare the effects of crime on individual labor outcomes in Mexico among different types of workers, as skilled-unskilled and white-blue collar worker. Moreover, we would be able to distinguish and measure the violence impact between different economic sector, since the MCO, accounts for specific occupations in the Agriculture, manufacturing and service economic sectors.

The results suggest that individual performing occupations related to Agriculture and service sector, has been by far more negative affected by the increasing drug-related violence across Mexico. In the case of workers in Agriculture, the estimation predicts that an increase of one unit in the homicide rate is associated with a decline of 4.5 and 6.3 percentage points in their monthly wage income and monthly total income. In addition we find that, the same change in the homicide rate will reduce the number of total hours worked a week by 2.2 percentage points. These negative effect of violence over monthly income and hours worked for agriculture workers in Mexico, might be explained by considering the fact that, in Latin America, violence has significantly affected the efficiency of farm holdings due to the disruption of rural labor markets and limits imposed on the operation of larger farms. In addition, Farms are vulnerable to crime because their expansiveness and relative openness makes it difficult and very expensive to secure them.

Moreover, according to Bozzoli and Brück (2009) and Verpoorten (2009) farmers react to conflict shocks by changing production decisions, preferring to invest in seasonal crops when facing more negative violent shocks, because this kind of crops represent less victimization risk, although are also less profitable, thus farmers are driven to a low-income equilibrium. The other channel through which violence negatively might impact the farmer's income, is related to the decrease in access to exchange markets. In particular, increasing violence becomes rural routes and tertiary roads more dangerous, due to criminals groups presence, increasing transaction costs for agriculture workers involved in market exchanges and, in extreme cases, resulting in return to subsistence activities. Fernández et al. (2011).

From the experience of other Latin American countries, the decrease in agricultural worker's income might led to farmers allocate an increasing proportion of their land to the production of illicit crops such as coca leaf. Increasing coca production and thus cocaine exports in turn, further fueled and prolong the violence spiral by providing cartels with important financial resources from drug-trafficking to continue and expand their activities.

According to the MCO, in the personal service occupation group, are included those workers providing personal services to the public, such as: customer service in restaurants, coffee shops, hotels, cleaning services. Moreover, workers dedicated to personal care, as is the haircut and beauty treatments. As well workers in rental services of personal property, such as vehicles, costumes, videos, machinery and other objects. Likewise, workers that provide auxiliary services in the shows, tourism and sports.

The estimation results indicate that for workers in occupations relate to personal service, the violence represents a negative shock for their monthly wage income and total monthly income. In particular, the results suggest that an one unit increase of 1 per 100.000 in the homicide rate, will reduce the monthly wage income and the total monthly income by 3 and 3.9 percentage points, respectively. Increasing violent crime, generates a real and perceive sensation of insecurity while people is doing outdoors activities, such insecurity feeling and the possibility of being target by crime, can be higher at night. Decreasing the incentives and willingness to perform outdoor activities, such as visit restaurants, bars, assist to public shows, demand personal services without security measures, or even traveling to those areas. Decreasing in turn, the demand for hotels rooms, restaurants, tourism and personal care services. Affecting the workers' income in these occupations. For instance in the recent years, the situation in some Mexico's most touristic areas, have escalated to one of the most violent areas in the country. Where, while the big cartels are fighting over the drug trade, small drug-related groups extort and kidnap the population, merchants, owners of bars and clubs.

Regarding to the results obtained for worker in safety staff occupations. The workers classified in this main group are dedicated to the protection and safety of people and their assets, specially against criminal acts. They also dedicate to maintaining public order and law enforcement. As it might expected, the demand for these sort of occupations have rise with the increasing violence in Mexico. Specifically, we find that for workers in this occupation category, the number of hours worked a week and the probability of being employed have increased. For instance, a one unit increase in the average homicide rate over the last 24 months prior to the interview date (1 per 100.000), will increase the number of hours worked a week by 6.6 percentage points, while the same change in the homicide rate, will cause an increase the probability of being employ by 1.4 percentage points, for an average worker with a safety staff occupation. Demand for guards is especially strong in developing countries, where hiring guards is more affordable than investing in technology-related services due to low labor costs.

On the other hand, in the case of professional workers category, accounting for those holding a College, Master or PhD degree, in several knowledge areas as: engineering, social sciences, Health sciences, among others. We find a positive effect of increasing violence on their labor market outcomes. The results this group, are suggesting a slight increase on the probability of being employed and participating in the labor market, as well as, the number of hours worked a week. Moreover, workers with professional occupations, exhibit increases in their monthly wage and total income. The estimation results predict, that a increase in the homicide rate of 1 per 100.000 inhabitants, translate in an increase of 5.3 and 4.9 percentage points in the monthly wage and total income for this type of occupations. Since more educated workers earn more, the are able to invest in security measures that undermine the risk of assets loses in violent times. Moreover, professionals usually perform occupations and live, in more safer areas and municipalities, where the public and private infrastructure against the crime might be more developed.

The interaction of these effects among blue-collar, unskilled and white-collar, skilled workers, present evidence to argued that violence in Mexico have a disproportionated impact of different types of workers. While, increasing violence in Mexico, represents a negative shock among blue-collar, unskilled workers. Labor market outcomes among white-collar, skilled workers have increased. These evidence is in tune, we recently findings of the effects of crime at the firm-level in Mexico, arguing that violence acts as a negative blue-collar labor supply shock, leading to significant increase in skill-intensity within firms Utar (2018).

Finally for workers with occupations relate to arts, shows and sport, we find that the number of hours worked a week have been significantly affected by drug related violence. In that sense, an increase of 1 per 100.000 in the homicide rate, is associated with a 20 percentage points decline in the weekly hours worked by workers in these occupations. Furthermore, as it might expected, we did not find significants effects of increasing crime for workers performing occupations in indoor places, as Educators, administrative activities. Specially, we find not significants effects, of violence on labor market outcomes for workers in occupations in the manufacturing sector.[8]

[8] For instance, occupations as: operators of fixed Machinery and equipment for industrial production and Assistants, peons and similar in manufacturing process and in repair and maintenance activities.

VI. Concluding Remarks

An improved understanding of the effects of violence on individuals economy is an important prerequisite for the definition of appropriate policies of prevention, assistance, and protection. This article contributes to such an understanding through the development of a empirical analysis of the effects of violent crime, expressed in the homicide rate rise in Mexico, over the labor market outcomes at the individuals level.

Focusing on the case of Mexico, the empirical framework has permitted us to provide a more rigorous assessment of the specific impact of increasing violence on individual labor outcomes. The econometric results suggests the negative effect of drug related homicide and akin violence over the labor market participation probability, employed status and income variables. The findings indicate that the effect of violent crime tend to be more significant for workers located at low levels of skill and the income distribution, compared with their peers at the high skill and income group, these results holds regardless of gender. Moreover, we find evidence to suggest that homicides negatively impact the amount of hours people work, such negative effect is predominant among self-employed, blue-collar, unskilled workers and people located in the low quintiles of the income distribution.

These finding are robust to taking into account the endogeneity of violence, by using geographical and cocaine supply in Mexico as identifying instruments. Moreover, the results expressed in this study are also robust to controlling for endogenous migration within our sample.

The presence of government security forces may help to reduce insecurity in areas of high violence. Given that direct threats are negative affecting individuals working activities, government protection should also concentrate on low income and unskilled group that have been identified as most affected.

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Tables and Figures

Table 1: *Checking for Endogenous Migration within the MxFLS*

Variables	(1) Migration 05-09	(2) Migration 05-09
Δ Homicide Rate 05-09	0.127%	
	(0.002)	
Homicide rate Interacted with Household and Individuals Characteristics		
Household Size		0.026%**
		(0.001)
Education Level		-5.6e-05
		(0.001)
Total Number of Children		0.022%*
		(0.001)
Number Children under 18 years old		0.017%***
		(0.001)
Number Babies (Children under 3 years old)		0.013%
		(0.0001)
Individual is Female		0.032%
		(0.003)
Individual is Male		0.305%
		(0.004)
Individual is Married		0.136%
		(0.002)
Individual is Not Married		0.105%
		(0.002)
Household Head Individuals		0.14%
		(0.002)
Observations	39199	39199
Number of Individuals	26796	26796

Robust standard errors in parentheses, clustered by municipality level

*** p<0.01, ** p<0.05, * p<0.1

All estimations include as Individual Characteristics as controls

Table 2: *First Stage IV Results*

VARIABLES	(1) Homicide rate	(2) Homicide rate	(3) Homicide rate	(4) Homicide rate
Instrument	-0.0599**	-0.0609**	-0.0581**	-0.0587**
	(0.028)	(0.029)	(0.028)	(0.025)
Individual Characteristics	✓			
Household Characteristics	✓	✓		
Municipality Features	✓	✓	✓	
Time Fixed Effects	✓	✓	✓	✓
Individual Fixed Effects	✓	✓	✓	✓
LM statistic (p-value)	5.14 (0.023)	4.92 (0.026)	5.55 (0.018)	5.46 (0.019)
Wald F statistic	32.85	33.62	32.25	27.6

Robust standard errors in parentheses clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1

Table 3: *Impact of Homicide Rate on Individuals labor Market Participation*

	All Individuals									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Avg Homicide rate	-0.060**	-0.060*	-0.061**	-0.018	-0.023*	-0.021*	-0.018*	-0.018	-0.091***	-0.039
	(0.028)	(0.028)	(0.028)	(0.011)	(0.012)	(0.012)	(0.011)	(0.012)	(0.030)	(0.029)
Avg Homicide rate*I(17-35 age group)		0.001								
		(0.004)								
Avg Homicide rate*I(36-60 age group)			0.002							
			(0.003)							
Homicide rate*I(Self Employed)				-0.007						
				(0.002)						
Avg Homicide rate interacted by Income level										
Avg Homicide rate*I(High Income top 20%)					0.001					
					(0.001)					
Avg Homicide rate*I(Low Income)						-0.005**				
						(0.002)				
Avg Homicide rate interacted with Skill level										
Avg Homicide rate*I(High Skilled worker)							0.008			
							(0.001)			
Avg Homicide rate*I(Low Skilled worker)								-0.007		
								(0.001)		
Avg Homicide rate interacted by Gender										
Avg Homicide rate*I(Female)									0.052***	
									(0.012)	
Avg Homicide rate*I(Male)										-0.051***
										(0.012)
Number of Observations	23802	23802	23802	9568	6870	6870	9510	9510	23802	23802
Number of Individuals	11900	11900	11900	4784	3435	3435	4755	4755	11900	11900
Wald F statistic	206.1***	102.9***	103.1***	60.9***	60.2***	60***	67.9***	68.2***	103.1***	103.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 4: *Impact of Homicide Rate on Individuals labor Market Participation, by Gender*

	Females							Males						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.079*	-0.078*	-0.054*	-0.067**	-0.061**	-0.055*	-0.055*	-0.028	-0.032	-0.0005	-0.004	-0.003	-0.001	0.001
	(0.041)	(0.042)	(0.030)	(0.031	(0.031)	(0.031)	(0.032)	(0.029)	(0.027)	(0.007)	(0.008)	(0.066)	(0.007)	(0.008)
Homicide rate*I(17-35 age group)	0.001							0.005						
	(0.005)							(0.004)						
Homicide rate*I(36-60 age group)		-0.008							0.007*					
		(0.004)							(0.004)					
Homicide rate*I(Self Employed)			-0.015**							-0.001				
			(0.007)							(0.001)				
Avg Homicide rate interacted by Income level														
Homicide rate*I(High Income top 20)				0.006							0.001			
				(0.006)							(0.001)			
Homicide rate*I(Low Income)					-0.017**							-0.001		
					(0.007)							(0.001)		
Avg Homicide rate interacted with Skill level														
Homicide rate*I(High Skilled worker)						-0.001							0.002	
						(0.005)							(0.001)	
Homicide rate*I(Low Skilled worker)							0.007							-0.002*
							(0.004)							(0.001)
Number of Observations	14176	14176	2754	1954	1954	2730	2730	9626	9626	6814	4916	4916	6780	6780
Number of Individuals	7087	7087	1377	977	977	1365	1365	4813	4813	3407	2458	2458	3390	3390
Wald F statistics	60.3***	60.3***	17.8***	22.1***	22***	17.7***	16.8***	40.7***	41.1***	45.4***	36.4***	36.1***	50.7***	51.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 5: *Impact of Homicide rate on Individuals likelihood of being Employed*

	All Individuals									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Avg Homicide rate	-0.036*	-0.038*	-0.035	-0.011	-0.024**	-0.018	-0.012	-0.010	-0.052**	-0.026
	(0.021)	(0.021)	(0.021)	(0.012)	(0.013)	(0.013)	(0.013)	(0.014)	(0.023)	(0.022)
Avg Homicide rate*I(17-35 age group)		0.005								
		(0.003)								
Avg Homicide rate*I(36-60 age group)			-0.001							
			(0.002)							
Homicide rate*I(Self Employed)				-0.007**						
				(0.002)						
Avg Homicide rate interacted by Income level										
Avg Homicide rate*I(High Income top 20%)					0 .004*					
					(0.002)					
Avg Homicide rate*I(Low Income)						-0.009**				
						(0.002)				
Avg Homicide rate interacted with Skill level										
Avg Homicide rate*I(High Skilled worker)							0.003			
							(0.002)			
Avg Homicide rate*I(Low Skilled worker)								-0.002		
								(0.001)		
Avg Homicide rate interacted by Gender										
Avg Homicide rate*I(Female)									0.026**	
									(0.010)	
Avg Homicide rate*I(Male)										-0.026**
										(0.011)
Number of Observations	23802	23802	23802	9568	6870	6870	9510	9510	23802	23802
Number of Individuals	11900	11900	11900	4784	3435	3435	4755	4755	11900	11900
Wald F statistic	206.1***	102.9***	103.1***	60.9***	60.2***	60***	67.9***	68.2***	103.1***	103.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 6: *Impact of Homicide rate on Individuals likelihood of being Employed by Gender*

	Females							Males						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.052	-0.050	-0.041	-0.066**	-0.058*	-0.041	-0.041	-0.010	-0.008	-0.002	-0.006	-.002	.001	.004
	(0.032)	(0.032)	(0.027)	(0.032)	(0.031)	(0.029)	(0.030)	(0.034)	(0.032)	(0.012)	(0.013)	(0.013)	(0.012)	(0.013)
Homicide rate*I(17-35 age group)	0.002							0.007						
	(0.005)							(0.005)						
Homicide rate*I(36-60 age group)		-0.001							0.002					
		(0.003)							(0.004)					
Homicide rate*I(Self Employed)			-0.017							-0.001				
			(0.008)							(0.002)				
Avg Homicide rate interacted by Income level														
Homicide rate*I(High Income top 20)				0.011							0.003*			
				(0.007)							(0.001)			
Homicide rate*I(Low Income)					-0.019**							-0.006***		
					(0.007)							(0.002)		
Avg Homicide rate interacted with Skill level														
Homicide rate*I(High Skilled worker)						-0.009							0.002	
						(0.005)							(0.002)	
Homicide rate*I(Low Skilled worker)							-0.004							-0.004**
							(0.004)							(0.002)
Number of Observations	14176	14176	2754	1954	1954	2730	2730	9626	9626	6814	4916	4916	6780	6780
Number of Individuals	7087	7087	1377	977	977	1365	1365	4813	4813	3407	2458	2458	3390	3390
Wald F statistic	60.3***	60.3***	17.8***	22.1***	22***	17.7***	16.8***	40.7***	41.1***	45.4***	36.4***	36.1***	50.7***	51.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 7: *Impact of Homicide rate on Individuals Total Number of Working Hours*

	All Individuals									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Avg Homicide rate	-0.043	-0.047	-0.039	-0.040	-0.049	-0.019	-0.046	-0.050	-0.049	0.028
	(0.065)	(0.065)	(0.064)	(0.065)	(0.059)	(0.058)	(0.064)	(0.066)	(0.064)	(0.069)
Avg Homicide rate*I(17-35 age group)		0.010								
		(0.011)								
Avg Homicide rate*I(36-60 age group)			-0.007							
			(0.009)							
Homicide rate*I(Self Employed)				-0.029***						
				(0.009)						
Avg Homicide rate interacted by Income level										
Avg Homicide rate*I(High Income top 20%)					0.023**					
					(0.009)					
Avg Homicide rate*I(Low Income)						-0.058***				
						(0.010)				
Avg Homicide rate interacted with Skill level										
Avg Homicide rate*I(High Skilled worker)							-0.016*			
							(0.009)			
Avg Homicide rate*I(Low Skilled worker)								0.002		
								(0.008)		
Avg Homicide rate interacted by Gender										
Avg Homicide rate*I(Female)									0.021	
									(0.028)	
Avg Homicide rate*I(Male)										0.023
										(0.028)
Number of Observations	9864	9864	9864	9864	7092	7092	9784	9784	23802	23802
Number of Individuals	4932	4932	4932	4932	3546	3546	4892	4892	11900	11900
Wald F statistic	84.7***	42.1***	42.3***	42.3***	45.5***	45.5***	45.9***	46.2***	103.1***	103.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 8: *Impact of Homicide rate on Individuals Total Number of Working Hours, by Gender*

	Females							Males						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.088	-0.078	-0.088	-0.001	0.025	-0.091	-0.089	-0.035	-0.029	-0.028	-0.081	-0.053	-0.033	-0.038
	(0.118)	(0.116)	(0.119)	(0.081)	(0.076)	(0.123)	(0.126)	(0.066)	(0.064)	(0.065)	(0.074)	(0.073)	(0.062)	(0.066)
Homicide rate*I(17-35 age group)	0.004							0.013						
	(0.021)							(0.012)						
Homicide rate*I(36-60 age group)		-0.015							-0.002					
		(0.018)							(0.009)					
Homicide rate*I(Self Employed)			-0.062***							-0.013				
			(0.019)							(0.009)				
Avg Homicide rate interacted by Income level														
Homicide rate*I(High Income top 20)				0.028							0.020**			
				(0.018)							(0.010)			
Homicide rate*I(Low Income)					-0.085***							-0.046***		
					(0.022)							(0.010)		
Avg Homicide rate interacted with Skill level														
Homicide rate*I(High Skilled worker)						-0.007							-0.017*	
						(0.017)							(0.010)	
Homicide rate*I(Low Skilled worker)							-0.004							0.003
							(0.013)							(0.009)
Number of Observations	2908	2908	2908	2062	2062	2872	2872	6956	6956	6956	5,030	5030	6912	6912
Number of Individuals	1454	1454	1454	1031	1031	1436	1436	3478	3478	3478	2515	2515	3456	3456
Wald F statistic	8.7***	8.8***	8.8***	17.4***	17.3***	8.3***	8.4***	33.3***	33.4***	33.4***	27***	26.8***	39.1***	39.2***

Robust standard errors in parentheses, clustered by municipality level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = $p < .05$ less than 10% IV bias, ** = $p < .05$ less than 15% IV bias, *= $p < .05$ less than 20% IV bias

Table 9: *Impact of Homicide rate on Individuals Monthly Wage Income*

	All Individuals								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)
Avg Homicide rate	-0.044	-0.054	-0.028	-0.205**	0.012	-0.066	-0.057	0 .029	-0.027
	(0.066)	(0.065)	(0.064)	(0.092)	(0.060)	(0.066)	(0.072)	(0.038)	(0.068)
Avg Homicide rate*I(17-35 age group)		0.029*							
		(0.014)							
Avg Homicide rate*I(36-60 age group)			-0.020						
			(0.013)						
Avg Homicide rate interacted by Income level									
Avg Homicide rate*I(High Income top 20%)				0.273***					
				(0.024)					
Avg Homicide rate*I(Low Income)					-0.328***				
					(0.029)				
Avg Homicide rate interacted with Skill level									
Avg Homicide rate*I(High Skilled worker)						0.004			
						(0.014)			
Avg Homicide rate*I(Low Skilled worker)							-0.010		
							(0.014)		
Avg Homicide rate interacted by Gender									
Avg Homicide rate*I(Female)								-0.057	
								(0.070)	
Avg Homicide rate*I(Male)									-0.029
									(0.038)
Number of Observations	5014	5014	5014	5014	5014	4962	4962	5014	5014
Number of Individuals	2507	2507	2507	2507	2507	2481	2481	2507	2507
Wald F statistic	58.8***	29.7***	29.9***	29.6***	29.8***	34.0***	34.5***	29.1***	29.1***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 10: *Impact of Homicide rate on Individuals Monthly Wage Income, by Gender*

	Females						Males					
	(2)	(3)	(4)	(5)	(6)	(7)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.014	0.003	-0.128	0.034	-0.025	0.004	-0.072	-0.043	-0.248*	-0.008	-0.076	-0.076
	(0.095)	(0.094)	(0.096)	(0.085)	(0.096)	(0.106)	(0.089)	(0.087)	(0.125)	(0.084)	(0.383)	(0.951)
Homicide rate*I(17-35 age group)	0.018						0.036**					
	(0.021)						(0.018)					
Homicide rate*I(36-60 age group)		-0.019						-0.021				
		(0.019)						(0.016)				
Avg Homicide rate interacted by Income level												
Homicide rate*I(High Income top 20$\%$)			0.252***						0.279***			
			(0.024)						(0.026)			
Homicide rate*I(Low Income)				-0.272***						-0.355***		
				(0.035)						(0.031)		
Avg Homicide rate interacted with Skill level												
Homicide rate*I(High Skilled worker)					0.032**						-0.003	
					(0.015)						(0.019)	
Homicide rate*I(Low Skilled worker)						-0.037*						-0.001
						(0.019)						(0.018)
Number of Observations	1558	1558	1558	1558	1538	1538	3456	3456	3456	3232	3424	3220
Number of Individuals	779	779	779	779	769	769	1728	1728	1728	1616	1712	1610
Wald F statistic	12.5***	12.6***	12.5***	12.5***	11.7***	11.8***	16.1***	16.3***	16.1***	14.1***	20.6***	12.7***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 11: *Impact of Homicide Rate on Individuals Annual Wage Income*

	All Individuals								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(9)	(10)
Avg Homicide rate	-0.2377	-0.264*	-0.210	-0.350*	-0.204	-0.311	-0.223	-0.239	-0.236
	(0.153)	(0.160)	(0.1504)	(0.187)	(0.1679)	(0.257)	(0.189)	(0.156)	(0.159)
Avg Homicide rate*I(17-35 age group)		0.057*							
		(0.032)							
Avg Homicide rate*I(36-60 age group)			-0.045*						
			(0.026)						
Avg Homicide rate interacted by Income level									
Avg Homicide rate*I(High Income top 20%)				0.167***					
				(0.021)					
Avg Homicide rate*I(Low Income)					-0.297***				
					(0.034)				
Avg Homicide rate interacted with Skill level									
Avg Homicide rate*I(High Skilled worker)						-0.151			
						(0.204)			
Avg Homicide rate*I(Low Skilled worker)							-0.033		
							(0.132)		
Avg Homicide rate interacted by Gender									
Avg Homicide rate*I(Female)								0.003	
								(0.075)	
Avg Homicide rate*I(Male)									-0.003
									(0.038)
Number of Observations	4734	4734	4734	4706	4706	4690	4690	4734	4734
Number of Individuals	2367	2367	2367	2353	2353	4690	4690	2367	2367
Wald F statistic	54.9***	27.3***	27.5***	26.1***	26.5***	10.87***	24.5***	27.1***	27.2***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 12: *Impact of Homicide Rate on Individuals Annual Wage Earnings by Gender*

	Females						Males					
	(2)	(3)	(4)	(5)	(6)	(7)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.338	-0.309	-0.449*	-0.296	-0.258	-0.417	-0.216	-0.149	-0.293	-0.155	-0.227	-0.074
	(0.242)	(0.232)	(0.260)	(0.231)	(0.159)	(0.334)	(0.197)	(0.186)	(0.223)	(0.207)	(0.203)	(0.217)
Homicide rate*I(17-35 age group)	0.031						0.073**					
	(0.058)						(0.030)					
Homicide rate*I(36-60 age group)		-0.025						-0.054**				
		(0.051)						(0.024)				
Avg Homicide rate interacted by Income level												
Homicide rate*I(High Income top 20%)			0.215***						0.151***			
			(0.044)						(0.022)			
Homicide rate*I(Low Income)				-0.298***						-0.297***		
				(0.053)						(0.041)		
Avg Homicide rate interacted with Skill level												
Homicide rate*I(High Skilled worker)					0.048						0.278	
					(0.147)						(0.263)	
Homicide rate*I(Low Skilled worker)						0.075						-0.126
						(0.155)						(0.199)
Number of Observations	1484	1484	1474	1474	1470	1470	3250	3250	3232	3232	3220	3220
Number of Individuals	742	742	737	737	735	735	1625	1625	1616	1616	1610	1610
Wald F statistic	12.08***	12.15***	11.8***	11.87***	10.87***	9.5***	14.8***	14.93***	13.9***	14.1***	15.1***	12.7***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 13: *Impact of Homicide Rate on Individual Total Monthly Income*

	All Individuals									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Avg Homicide rate	-0.039	-0.047	-0.038	-0.040	-0.165**	0.057	-0.052	-0.031	-0.0493	-0.0208
	(0.069)	(0.070)	(0.067)	(0.068)	(0.074)	(0.058)	(0.067)	(0.070)	(0.069)	(0.072)
Avg Homicide rate*I(17-35 age group)		0.021								
		(0.014)								
Avg Homicide rate*I(36-60 age group)			-0.001							
			(0.013)							
Homicide rate*I(Self Employed)				-0.033*						
				(0.018)						
Avg Homicide rate interacted by Income level										
Avg Homicide rate*I(High Income top 20%)					0.281***					
					(0.024)					
Avg Homicide rate*I(Low Income)						-0.272***				
						(0.024)				
Avg Homicide rate interacted with Skill level										
Avg Homicide rate*I(High Skilled worker)							0.019			
							(0.012)			
Avg Homicide rate*I(Low Skilled worker)								-0.024**		
								(0.012)		
Avg Homicide rate interacted by Gender										
Avg Homicide rate*I(Female)									0.028	
									(0.038)	
Avg Homicide rate*I(Male)										-0.028
										(0.038)
Number of Observations	7204	7204	7204	7204	6888	6888	7136	7136	7204	7204
Number of Individuals	3602	3602	3602	3602	3344	3344	3568	3568	3602	3602
Wald F statistic	89.9***	44.8***	45.1***	44.8***	42.3***	42.5***	50.2***	50.3***	44.7***	44.7***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 14: *Impact of Homicide Rate on Individual Total Monthly Income by Gender*

	Females							Males						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg Homicide rate	-0.004	0.016	0.001	-0.088	0.060	-0.021	0.032	-0.057	-0.056	-0.0511	-0.198**	0.058	-0.056	-0.045
	(0.093)	(0.091)	(0.089)	(0.088)	(0.081)	(0.089)	(0.095)	(0.094)	(0.090)	(0.0917)	(0.099)	(0.078)	(0.089)	(0.095)
Homicide rate*I(17-35 age group)	0.019							0.019						
	(0.021)							(0.017)						
Homicide rate*I(36-60 age group)		-0.022							0.009					
		(0.021)							(0.016)					
Homicide rate*I(Self Employed)			-0.101***							-0.008				
			(0.036)							(0.018)				
Avg Homicide rate interacted by Income level														
Homicide rate*I(High Income top 20%)				0.285***							0.280***			
				(0.034)							(0.0261)			
Homicide rate*I(Low Income)					-0.258***							-0.277***		
					(0.030)							(0.024)		
Avg Homicide rate interacted with Skill level														
Homicide rate*I(High Skilled worker)						0.061***							0.008	
						(0.017)							(0.015)	
Homicide rate*I(Low Skilled worker)							-0.063***							-0.013
							(0.019)							(0.015)
Number of Observations	2136	2136	2136	2048	2048	2108	2108	5068	5068	5066	4840	4840	5028	5028
Number of Individuals	1068	1068	1068	1024	1024	1054	1054	2534	2534	2533	2420	2420	2514	2514
Wald F statistic	17.9***	17.9***	18***	16.8***	16.7***	17.2**	17.4**	25.8***	26.0**	25.7**	24.2***	24.2**	31.4***	31.3***

Robust standard errors in parentheses, clustered by municipality level. *** p<0.01, ** p<0.05, * p<0.1. All Models included time fixed effects and controls for household and individual characteristics. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 15: *Impact of Homicide Rate on Individual Labor Market Outcomes by Occupation*

	Labor Market Outcomes					
	(1)	(2)	(3)	(4)	(5)	(6)
Occupation/Outcome	Participating	Employed	Hours Worked	Monthly Income	Annual Income	Total Income
Professionals	0.007**	0.010**	0.021*	0.053***	0.041*	0.049***
	(0.003)	(0.004)	(0.011)	(0.018)	(0.024)	(0.015)
Technicians	-0.007**	-0.008**	-0.016	-0.030	-0.005	-0.015
	(0.003)	(0.004)	(0.010)	(0.022)	(0.032)	(0.016)
Educators	0.012*	0.0045	-0.038	-0.021	-0.032	0.058
	(0.006)	(0.010)	(0.028)	(0.027)	(0.040)	(0.036)
Workers in Art, Shows, and Sports	0.0153	0.006	-0.204***	0.033	-0.021	0.076
	(0.016)	(0.014)	(0.054)	(0.113)	(0.170)	(0.055)
Directors in Public and Private sectors	0.007	0.007	-0.040	-0.031	0.119*	0.087
	(0.015)	(0.014)	(0.046)	(0.057)	(0.071)	(0.055)
Workers in Agriculture	-0.004	0.003	-0.022*	-0.045**	-0.044	-0.063***
	(0.002)	(0.004)	(0.012)	(0.018)	(0.028)	(0.019)
Bosses and Supervisors	-0.014	0.001	-0.058	0.056	-0.269**	-0.014
	(0.016)	(0.023)	(0.059)	(0.064)	(0.105)	(0.016)
Workers in Production, Repair and Maintenance	-0.0012	-0.008*	0.007	0.029*	0.035	-0.017
	(0.003)	(0.004)	(0.012)	(0.017)	(0.031)	(0.049)
Operators of Machinery and Equipment	0.001	-0.0002	0.018	-0.007	-0.006	0.008
	(0.002)	(0.003)	(0.014)	(0.015)	(0.027)	(0.014)
Assistants in Production, Repair and Maintenance	0.004	0.008*	0.013	-0.002	-0.016	0.012
	(0.003)	(0.004)	(0.015)	(0.018)	(0.038)	(0.017)
Drivers and Assistants Drivers	-0.007**	-0.005	0.020	0.042	0.023	0.018
	(0.004)	(0.005)	(0.015)	(0.028)	(0.035)	(0.017)
Coordinators and Supervisors in Administrative Activities	-0.005	-0.006	0.010	-0.046	0.045	0.024
	(0.005)	(0.005)	(0.022)	(0.051)	(0.054)	(0.026)
Merchants and Sales Representatives	-0.006	-0.003	0.007	0.001	-0.004	-0.038
	(0.004)	(0.005)	(0.010)	(0.014)	(0.042)	(0.048)
Traveling Sales People	0.0102	0.00512	-0.0198	-0.0364	-0.153	0.00380
	(0.0142)	(0.0134)	(0.0344)	(0.0336)	(0.102)	(0.0137)
Workers in the Service Sector	0.006	0.006	0.001	-0.030**	0.010	-0.039**
	(0.006)	(0.006)	(0.013)	(0.021)	(0.032)	(0.017)
Domestic Workers	-0.008	-0.015	-0.016	0.019	-0.017	0.005
	(0.009)	(0.009)	(0.017)	(0.019)	(0.037)	(0.017)
Safety and Security Staff	0.009	0.014**	0.066***	0.013	0.023	0.023
	(0.006)	(0.008)	(0.019)	(0.027)	(0.043)	(0.022)
Observations	9,966	9,966	9,784	9,966	4,690	7,136
Number of ind_ID	4,983	4,983	4,892	4,983	2,345	3,568

All Models included time fixed effects and controls for household and individual characteristics. *** p<0.01, ** p<0.05, * p<0.1

A. Appendix

i. Data

Individual-level Data

Data on individuals socieconomic-conditions comes from Mexican Family Life Survey MxFLS. On an individual level, MxFLS collected detailed information on each household member including: level of education, retrospective migration background, marriage, fertility and any victimization occurring in the household (robbery, theft, kidnaps); work force participation; adult work earnings; money transfers and in kind; time allocation for adults and children; credit and loans; investments in human capital and the decision making process; health status perceptions, objective measures pertaining to their state of health (weight, size, waist and hip measurements, blood pressure levels, standard blood lab tests); reproductive health of all women within fertile age range and contraceptive methods and usage.

The survey's panel design allows a continuous tracking of those individuals and those families interviewed at the base line, regardless of their geographic location or economic mobility. Continuing with the MxFLS panel form considerably enrich the information available and allows to fully the effect of increasing Violent crime on individual's labor outcomes and especially to control for endogenous migration in the sample. Moreover, we were able to track the same individual in different years, given that once an individual is include in the survey, receives a unique individual indicator that stays constant throughout the different survey rounds allowing us to match individual information throughout the various rounds.

Homicide Data

Data on homicides in Mexico comes from the Mexican Statistic Authority (INEGI), this data provides information on all official reports of intentional homicides in Mexico. These reports are available from 1990 to 2011, which allows us to fully exploit the temporal variation in homicide rates in Mexico and the panel nature of the MxFLS. Moreover, to calculate the homicide rate per 100.000, we also obtain the population of each municipality in Mexico by year during the time frame of this study. In that sense to get the monthly homicide rate per 100.000, we assumed a constant population during the whole year.

Cocaine Seizures Data

The data on Cocaine Seizures and interdiction efforts against the production and commercialization of drugs in Colombia, comes from the Defense Department of Colombia or Ministerio de Defensa Nacional.

i.1 Additional Analysis and Descriptive Statistics

Variables Definition and Calculation

The employment status was define based on the question "What was your main activity last week" on MxFLS, which ask for the labor status at the interview time. The labor market participation variable is a dummy variable indicating 1 whether the individual answered "worked" or "looking for a Job" or were in "Vacations" but have a job and 0 otherwise.

The variable Employed, is a dummy variable indicating 1, whether the individual answered "worked" and 0 otherwise. It does not refer to any specific type of employment.

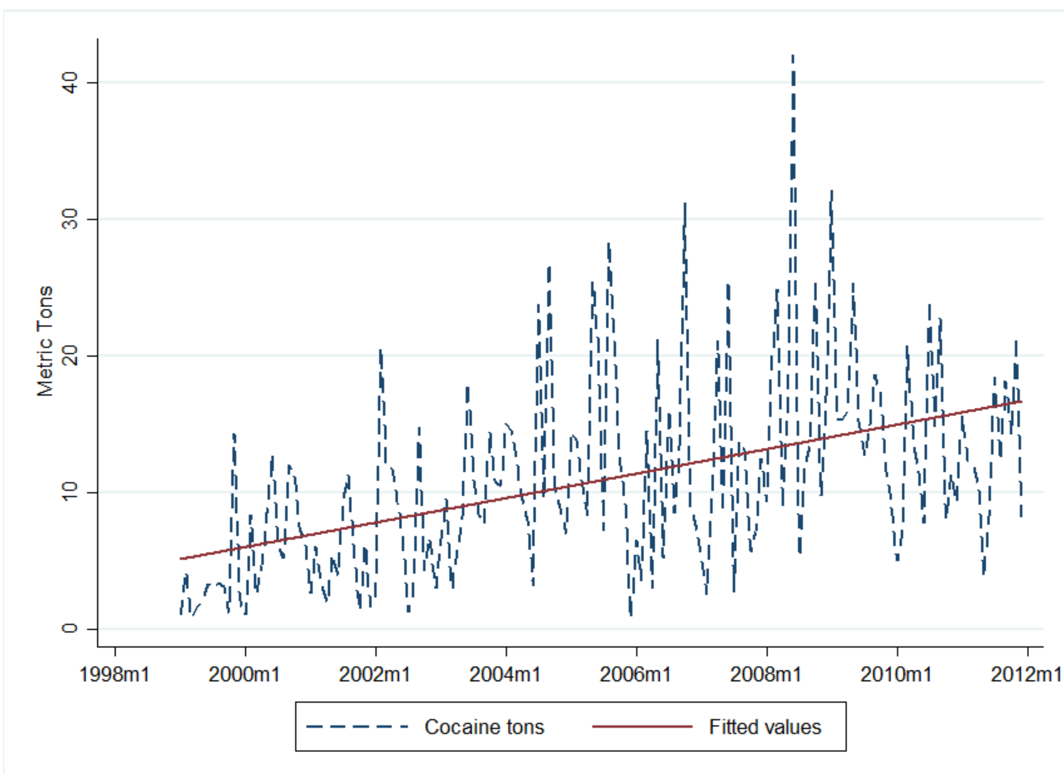
The variable lMonthly_earnings_mw: is log transformation of deflated monthly earnings from main work. It's available just for employees classified as dependent worker.

The variable lannual_income_business: is log transformation of the deflated annual income from main and secondary business. Was obtained by combining the net and gross annual business income. Specifically in this case was calculated based on the annual gross business income, for instance in that that individual i did not reported his or her annual business gross income, but reported his or her annual business net income, we consider this latter observation to complete the annual income business variable. This is possible given the marginal difference between net and gross income resulting from relative low wage-income taxes contributions. To give an idea in 2015, the mandatory contribution to the medical insurance, the retirement fund and others, were 1.25%, 0.037% and 0.85%, respectively.

The variable lmonthly_income_business: is log transformation of the deflated month income from main and secondary business. Was obtained by combining the net and gross month business income. Specifically in this case was calculated based on the month gross business income.

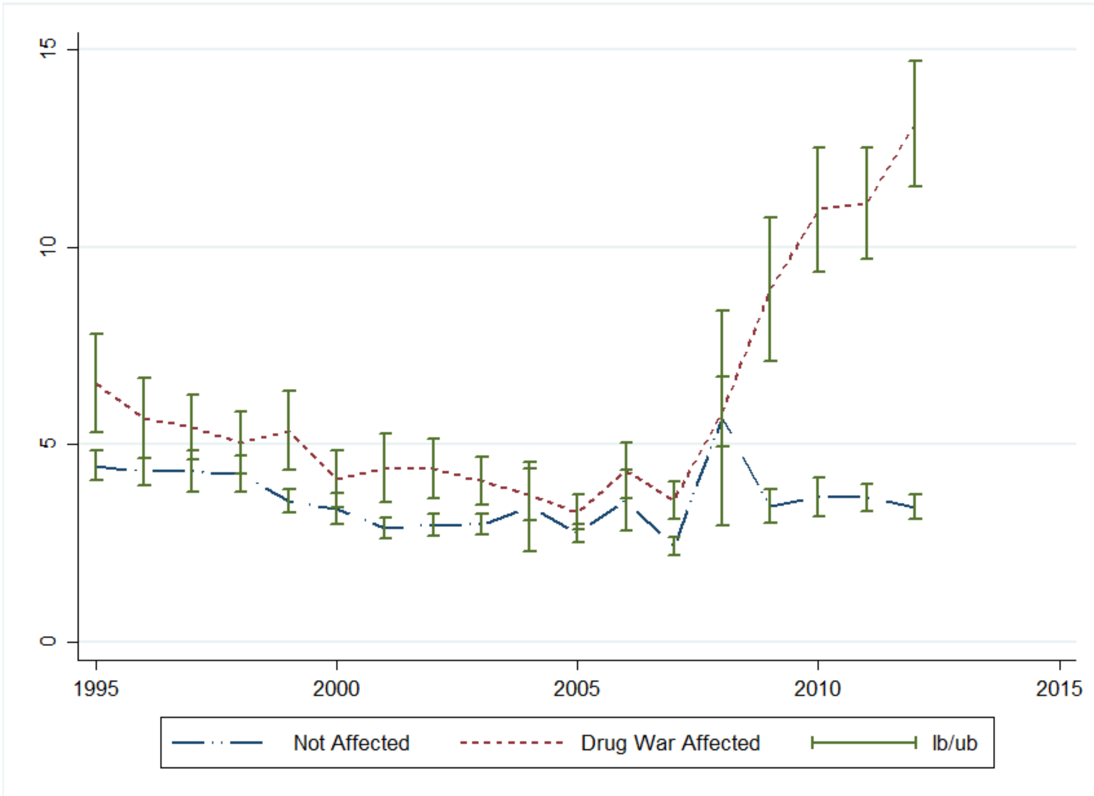
The variable lmonthly_income : is log transformation of monthly income for those individuals who are either working as a dependent employees or whose income is derived from a business activity. Was obtained by combining the monthly business income and the monthly earnings at main work.

Figure 2: *Monthly variation of Cocaine Seizures in Colombia.*



Source: Author's own calculation. Data comes from Defense Department of Colombia

Figure 4: *Homicide Rate across Drug-war Affected and Non-affected Municipalities in Mexico*



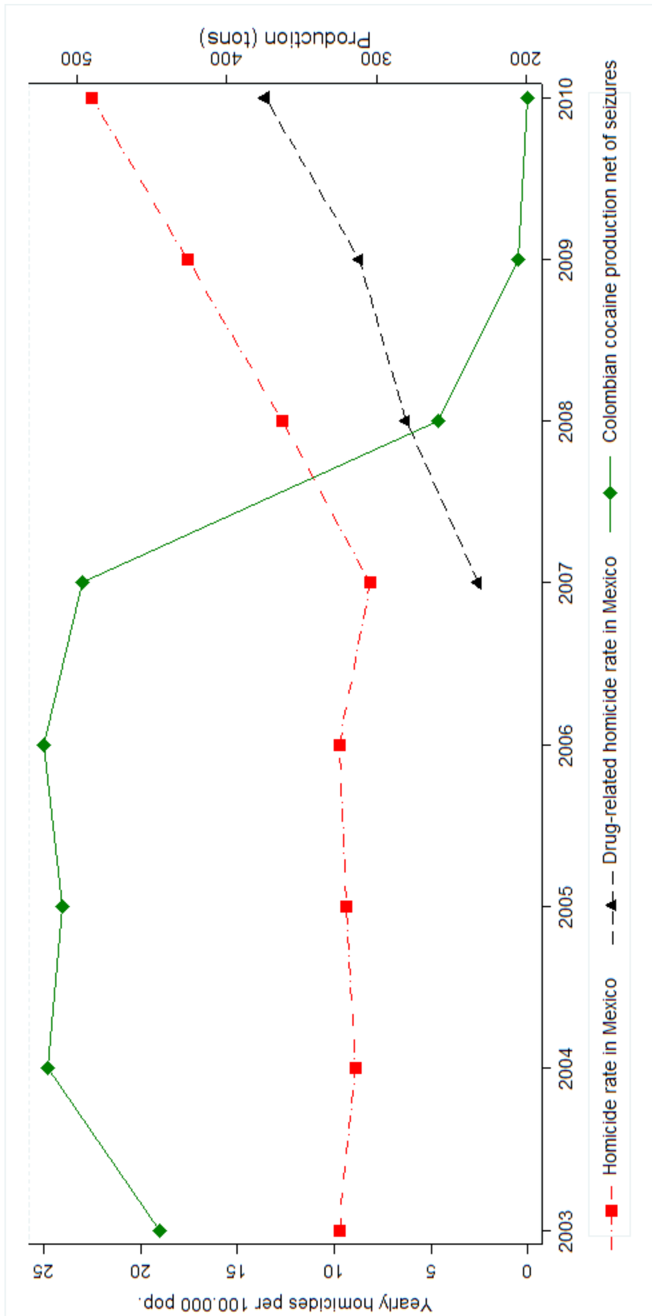
Note: Author's own calculation. we defined a municipality as affected or Non-affected, by comparing the average homicide rate five years before and after of the inflexion year 2007. Similar to, Coscia & Rios (2012). Such definition covers the 100 most violent municipalities. 90% of the municipalities with the highest homicide rates. 80% of the municipalities with greatest increases in homicide rates between the periods of 2002- 2005 and 2006-2010.

Table 16: *Mexican Municipalities features*

Variable	Mean	Std. Dev.	Min.	Max.	N
Total Population	312060.769	404691.455	409	1820888	120163
Proportion Males/Females	96.03	4.981	79.2	125	120163
Energy Supply	0.971	0.031	0.751	0.998	120163
Drinkable Water	0.91	0.104	0.358	0.999	120163
Educational Establishments	344.125	385.929	2	2449	87825
Number of Workers	72921.460	108330.813	10	733557	120163
Economic Units	12355.865	17431.446	5	90533	120163
Gross Output per worker	348.943	498.886	7	10509	116548

Data on Mexican Municipalities comes from INEGI. Energy supply and drinkable water, represents the share of households with access to these services at home.

Figure 3: *Yearly Homicide Rate in Mexico and Net Production of Cocaine in Colombia.*



Yearly homicide rate in Mexico, data comes from INEGI), drug-related homicide rate in Mexico data comes from Mexico's President's Office, and yearly cocaine production net of seizures in Colombia data comes from Defense Deparment of Colombia.

Table 17: *Distribution of Households across States in MxFLS-2 and MxFLS-3*

		MxFLS-2		MxFLS-3	
State Code	States	Obs.	Households	Obs.	Households
02	Baja California	0	0	59	12
03	Baja California Sur	1552	366	1775	395
04	Campeche	0	0	3	1
05	Coahuila de Zaragoza	1929	444	2396	500
06	Colima	0	0	3	1
07	Chiapas	2	2	8	2
09	Distrito Federal	826	197	920	207
10	Durango	2370	534	3121	635
11	Guanajuato	2596	529	3444	665
12	Guerrero	0	0	5	1
13	Hidalgo	0	0	14	4
14	Jalisco	2098	491	2370	516
15	Mexico	2934	618	3670	712
16	Michoacan de Ocampo	3138	668	3905	770
17	Morelos	1690	395	2012	406
18	Nayarit	0	0	10	2
19	Nuevo Leon	3040	709	3673	812
20	Oaxaca	2641	545	3124	610
21	Puebla	1955	417	2373	459
22	Queretaro	6	1	12	3
23	Quintana Roo	0	0	1	1
25	Sinaloa	3100	665	3703	734
26	Sonora	2976	674	3458	728
28	Tamaulipas	24	17	50	11
29	Tlaxcala	0	0	5	1
30	Veracruz de Ignacio	3379	790	4004	848
31	Yucatan	1595	358	1796	370
32	Zacatecas	0	0	6	2

Note: Author's own calculation. data on households comes from Mexican Family Life Survey (MxFLS).

Table 18: *Individuals Characteristic by Gender*

	Females					Males				
Variables	Obs.	Mean	sd	min	max	Obs.	Mean	sd	min	max
Education level	54,358	3.837	1.975	1	10	50,387	3.935	2.007	1	10
Hours Worked	11,502	37.51	19.21	1	95	21,281	44.98	16.76	1	95
Number of co-workers	11,081	44.80	309.2	1	16,000	20,543	61.47	588.0	1	40,019
Monthly Gross Income Business	**2,577**	1,514	5,896	0	150,000	**4,947**	3,372	37,761	0	2.000e+06
Monthly Net Income Business	**2,531**	1,541	5,148	0	160,000	**4,862**	2,794	10,362	0	358,000
Annual Gross Income Business	**2,332**	13,906	47,478	0	1,000,000	**4,580**	24,475	88,985	0	3.500e+06
Annual Net Income Business	**2,465**	13,985	73,608	0	3.240e+06	**4,801**	23,362	52,550	0	1,000,000
Weeks Worked	3,851	43.84	16.07	1	52	6,974	45.03	14.41	1	92
Annual Earnings	6,854	39,824	203,279	0	1.234e+07	13,283	43,393	184,860	0	2.000e+07
Monthly Earnings	7,123	3,907	20,935	0	1.400e+06	13,817	4,862	86,254	0	1.000e+07
Financial Assets	1,341	101,311	2.731e+06	8	1.000e+08	1,581	33,107	85,542	8	1.200e+06
House(s) Value	38,920	39,039	365,801	0	6.010e+07	36,600	51,157	675,336	0	1.000e+08
College Degree	55,187	0.0660	0.248	0	1	51,222	0.0753	0.264	0	1
Divorced	45,727	0.0386	0.193	0	1	41,766	0.0192	0.137	0	1
Self Employed	11,637	0.197	0.398	0	1	21,563	0.138	0.345	0	1
Employed	36,133	0.285	0.452	0	1	29,325	0.734	0.442	0	1
Owns Occupied House	10,033	0.750	0.433	0	1	9,407	0.736	0.441	0	1
Age	58,844	28.82	20.27	17	102	55,001	28.10	20.37	17	99
Households Assets	17,695	31,811	495,314	0	6.010e+07	16,428	44,312	970,869	0	1.000e+08

Note: Author's own calculation. data on households comes from Mexican Family Life Survey (MxFLS).

Chapter 2.
The Effect of Chinese Import Competition on Manufacturing plants Performance

Victor Zapata*

Abstract

This paper studies the effects of Chinese import competition on manufacturing plants in developing economies. By employing a rich plant-level data for Colombian manufacturing plants covering the period 2000-2012, that enables to compare the performance for the same plant before and during incresing intensity of Chinese import competition. By exploiting the exogenous acceleration of Chinese imports in conjunction with the WTO accession of China, the empirical analysis reveals significants and disproportionated effects of intensified Chinese competition across heterogeneous plants. In particular, competition from China has negative and significant impact on employment, sales, value added and plant output. The employment losses that take place within labor-intensive plants, are mainly driven by the negative impact of Chinese import on employment among relative more skilled-intensive plants, rather than in unskilled-intensive plants. Aditionally, increasing Chinese competitive pressure, encourages plant exit and discourages entry, whereas, skill upgrading only occurrs in more productive and more capital-intensive plants. These finding are robust to taking into account the endogeneity of Colombian imports demand from China.

JEL Classification: *F14 F61, L25, L60*

Keywords: *Import Competition, Manufacturing Plants, Import Penetration Rate, Trade Policy, Market Share, Industry Output.*

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I. Introduction

Certainly one of the striking changes in the world trade in the last decades has been the emerging of China as a new big player. Specifically, China's export surge is the outcome of economic reforms in the 80's and 90's, which were fueled by the country's accession to the WTO in 2001 and nowadays it categorize China as the world leading exporter, above from the entire European Union and United States. Between 1990 and 2011, the share of world manufacturing exports originating in China increased from 2% to 16% (Hanson, 2012). This rapid evolution of world imports from China has motived an increasing literature from both trade economists and labor economists focusing on study the its impacts on domestic labor-market outcomes and industry evolution in the manufacturing sector. Especially in labor-intensive industries where China is believed to concentrate its comparative advantage. Such studies are especially important since developed economies, have evidenced employment downturn, greater income inequality between skilled and unskilled workers and languish performance in the manufacturing sector. For instance, Acemoglu et al. (2016) argued that after staying relatively constant during the 1990s, US manufacturing employment declined by 18.7% between 2000 and 2007, coinciding with a significant increase in import competition from China and others low-wage economies.

The aim of this paper is to investigate the impact of import competition from China on the performance of Manufacturing plants in developing economies, using plant-level data for Colombia. Moreover, empirical studies of firm units within sectors have reported a massive amount of heterogeneity in various performance measures (most notably, size, productivity and age). This heterogeneity, within sectors, matters for theoretical and empirical models of trade. Therefore, our results are analyzed by different types of plants, regarding market share within its specific industry, workers size, productivity, capital-intensity, relative age and relative skill-intensity. Using plant-level data to analyze Chinese import competition effects, represents some advantages over those studies using industry-level data, since studies employing aggregate level data have some shortcomings. First, the exact mechanisms of the role of imports in domestic productivity growth could be hidden by using aggregated or country level data (Brambilla et al., 2010). Firm heterogeneity may affect firm productivity and competition response, but with plant-level data can be addressed. (Kasahara and Rodrigue, 2008). Furthermore, Halpern et al. (2005) showed that the studies at macro-level may suffer from the problems of omitted variables and reverse causality biases.

An increasing interest in examining the effect of Chinese import penetration on firm performance is observed in some developed countries.[1] However, the impact of low-wage imports –as in the case of China– on firm's behavior and performance in developed countries may not hold for the developing economies, where firms are typically less technologically advanced, have a low level of development, and lack the capacity and resources to innovate and compete with imports. Moreover, insufficient work has been carried out in developing countries, where even among this category of economies the heterogeneity of the structure of manufacturing industries, might result in additional and new findings. Specifically, the existing literature in this regard, have mainly focused on the effect of increasing Chinese import competition for Mexican maquiladoras competing in the U.S market. Utar and Ruiz (2013) argued that Competition from China has negative and significant impact on employment and plant growth, both through the intensive and the extensive margin, on the most unskilled labor intensive sectors, leading to sectoral reallocation. Furthermore, Iacovone et al. (2013), Chinese import penetration reduces sales of smaller Mexican plants and more marginal products and they are more likely to cease.

This paper contributes to this stream of literature exploring the plant-level effects of Chinese import competition, specially because it represents the first study for the case of Colombian manufacturing plants analyzing this issue. The Colombian case, it pretty interesting given the almost 30 years of trade reforms, that changed the protection structure and reflected the country's commitment to economy-wide reforms that reduced

[1] Bernard et al. (2006), American plant survival and growth are negatively correlated with industry exposure to imports from low wage countries. Mion and Zhu (2013) using Belgian firms data, found that industry-level import competition from China reduces firm employment growth and induce skill upgrading in low-tech manufacturing industries. Bugamelli et al. (2010) increased import competition from China has affected Italian firms' pricing strategies causing a reduction in the dynamics of prices and markups. Among others.

tariff, and set tariff rates to levels comparable to those in developed countries. Since these rates were negotiated with the WTO, Industry representatives had less opportunity to pursue special lobby interests and therefore, from an individual industry's perspective, the final tariff rates were exogenously predetermined. (Attanasio et al., 2004). In that sense, Colombia was fully integrated to the world economy –specially with low tariffs for industry related imports– when the China accession to the WTO took place in December 2001.

In order to identify the impact of heightened Chinese import competition on manufacturing plants in Colombia, the identification strategy rely on an instrumental variable approach to deal with the reverse causality problem that arises, due to factors such as demand or technology shocks for particular products or industries in the domestic market can be correlated with the firm performance and the industry-level of Chinese imports. The identification strategy exploits the exogenous intensification of Chinese imports in the rest of the world and the fact that not all plants are exposed to the competition in the same extent. This procedure allow to identify the causal of Chinese import competition on manufacturing plants performance and industrial evolution. First, we show the "first order effects" of Chinese competition on plants' output, sales, value added, employment and wages. Then analysis move to the evolution manufacturing plants in finely disaggregated industries with respect to plants' entry, exit, productivity and possible skill upgrading. We employ data from a plant-level survey that is representative of all manufacturing plants in Colombia with more than 10 employees. The richness of this plant-level data, allows to identify valuable plant characteristics as: plant specify productivity, capital-labor ratio, relative age, market share and employment skill composition. The sample starts in 2000 where Chinese import share in Colombian total imports 3% and covers until 2012 where China's import share became 16.5%.

The findings are marked by the differential effect of import competition across heterogeneous plants, presenting a disproportionated effect of Chinese competition among different types of plants. Specifically, bigger plants in terms of market share and employment are more able to mitigate the negative effects of Chinese import competition compare to the small plants. Moreover, as the standard theory predict, we find that productivity is a key determinant of the impact of import competition for each manufacturing plant. One contribution of this paper, is to present the fact that in developing economies as Colombia, intensified Chinese import competition have reduced the employment in labor-intensive manufacturing plants compared to the capital-intensive ones, we argue that employment losses within labor-intensive plants, are mainly driven by the negative impact of Chinese import competition on the number of total workers in relative more skilled-intensive plants, rather than in unskilled-intensive plants, as the standard evidence suggest in the case of developed economies, such effect is due to the rapid technology advanced of China compare to Colombia and the fact that labor reforms in Colombia during 2000s, granted the possibility to Colombian firms to outsource domestically unskilled employment. Additionally, whereas, increasing Chinese competitive pressure, have a significant effect on plant's probability of exit, specially among relative younger and less productive plants, it discourages entry of new manufacturing plants, these effects might cause more concentration and aggregate productivity growth at industry level. Finally, the analysis of the impact of Chinese import competition on skill intensity among different types of plants, shows that there is not evidence of existing skill upgrading in response to import competition from China, regardless size or relative age of manufacturing plants. However, we find that import competition from China triggers skill upgrading only in more productive and more capital-intensive plants.

The paper continues as follows: In the next section presents a key aspect of bilateral trade between China and Colombia. Section III, introduced the theoretical considerations to understand the direction of the impact of Chinese imports on manufacturing industry. Section IV, contain a detail description of the data and its characteristics. Finally sections V and VI, present the methodological approach and the results analysis, followed by concluding remarks in section VII.

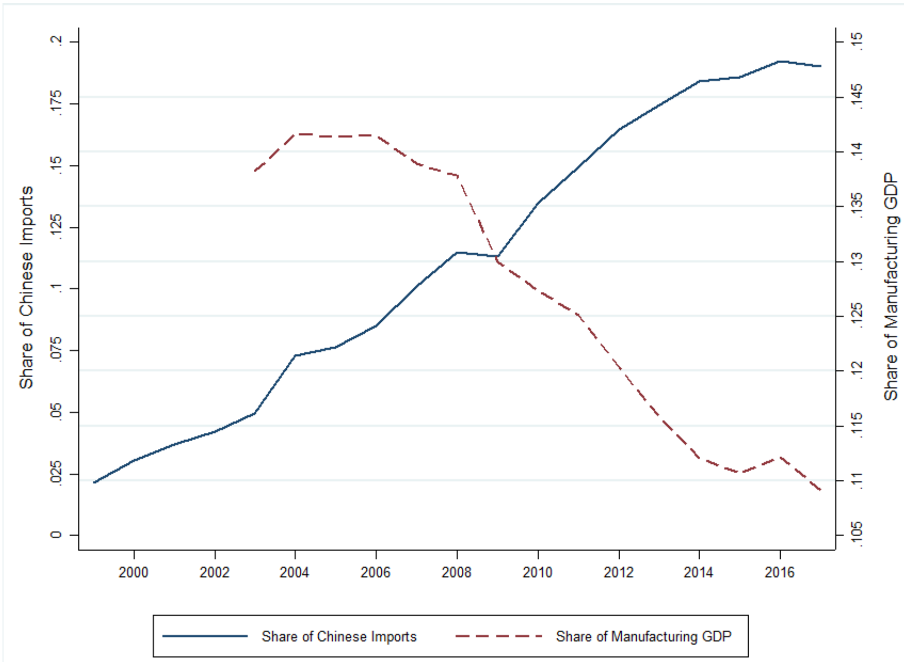
II. Bilateral trade Colombia-China: key aspects

In Colombia, the poor performance of the manufacturing sector has been seen as a key factor explaining slow growth and high unemployment. Given the Colombian economy dependency to primary goods, accentuated by the oil prices boom, many concerns have been expressed over the 'de-industrialization' of the economy, expressed in falling shares of manufacturing in total GDP and employment. (Echavarría et al., 2007; Clavijo et al., 2012; Goda and García, 2015). While it is true that the share of manufacturing industry in total GDP in Colombia has been falling during the years 1975 from around 24% to 15% in 2012. likewise, employment industry accounted 25% of total employment in late 80's has decrease up to 13% in 2012. Such phenomenon over the past decade, has been accentuated by the rapid growth of imports from China as figure 1 shows, causing further difficulties or even setting extra impediments for the manufacturing sector in Colombia. [2]

Since China joined the (WTO), bilateral trade between Colombia and China has grown rapidly, specially in the case of imports, figure 4 shows that China has become the second largest trade partner. Moreover, since the China surge, the share of import of products originating from U.S has dropped, from 37% to 25% in the period 2000-2012. Additionally, the rise of China seems to hampering the Mexican and Brazilian exports to Colombia, which gravity theory will suggest as more natural destination, in presence of relative similar exports baskets as the Chinese.

[2]Although the languished performance of Colombian industry sector may be explain by structural determinants or additional problems.

Figure 1: *Share of Imports from China over Total Imports (left scale), and Share of Manufacturing Industry GDP over total GDP (right scale) in Colombia.*



Source: Author's own calculation. Data comes from UNCOMTRADE

According to the trade theory, we consider that the effect of Chinese import competition on Colombian manufacturing plants will depend on: Whether imports from China compete primarily with other Colombian exporters or with local producers. In this study we assume that the import competition effect on local producers dominates over the competition of Colombian exporters, since row materials, minerals, agriculture products and crude represents more than the 85% of Colombian exports,[3] whereas, the manufacturing products only are a 5% of the total export basket in this country.

Second, whether the affected industries in Colombia are import competing industries, in which case they are likely to face falling profit margins and a reduced market share, or import-using industries, in which case cheaper Chinese inputs or capital goods would lead to higher profitability and expanded output. In this regard there is a extensive evidence

[3] According to the OCDE, in 2015 the top exports of Colombia were Crude Petroleum (25%), Coal Briquettes (16.5%), Coffee (7.8%), Refined Petroleum (5.9%) and Gold (4.2%)

suggesting that a positive effect of a increasing trade liberalization on firms' total factor productivity, due to the access to new input varieties, specifically importing intermediates inputs from high technology advanced countries. (Pavcnik, 2002; Khandelwal, 2010; Topalova and Khandelwal, 2011; Goldberg et al., 2010) among others. We consider that, contrary to the import of intermediaries inputs from developed economies, that might embedded technology and cause spill-over effects. The Colombian imports from China represent mainly final goods rather than high quality intermediate inputs. Therefore, we assume that is more likely that affected industries in Colombia by Chinese competition are import competing industries rather than input using. Third, how domestic manufacturers respond to increased competition in terms of lowering mark-ups, defensive innovation, or upgrading skill and quality.

III. Theoretical Considerations.

Being a populous country, China will exert a large impact on international markets with its labor-intensive goods. There is not other country in the world with a higher absolute quantity of labor. Moreover, a population of 1.38 billion and a labor force of roughly 640 millions, gives to China a high comparative advantage in labor-intensive goods. Therefore as the HOV theory suggest, countries tend to export goods that uses its abundant factor intensively.

Although, both China and Colombia have a comparative advantage in labor-intensive products. China has a comparative advantage in unskilled labor in comparison to Colombia. In 1999, approximately 13% of the Latin American population had post-secondary education, compared to 3% in China (Devlin et al., 2006). Factor content theory suggests that as trade liberalizes in China, industries that disproportionately employ unskilled workers will shrink in Colombia and the opposite will occur in China. This through the intensive margin evidence in a output shrink for manufacturing firms in Colombia. It might also happen through the extensive margin caused by firm exits as a result of the competition and/or that heightened competition discourages entry of new plants in those sectors where China's comparative advantage is greater.

Moreover, recent theoretical frameworks suggest that, assuming the labor demand curve is upward sloping, an increase in import competition in a product reduces the wages of the workers used to produce that product (Bernard et al., 2011). Since Chinese imports are primarily products produced with low-skilled labor, the theory predicts that low skilled workers' wages will fall in those firms facing higher Chinese import competition.

Even though labor abundant is clearly the main driver of China's competitive and comparative advantages, it does not mean that other sort of goods are ruled out as competition for developing economies as Colombia. Devlin et al. (2006), argue, given the uneven distribution of factors among its regions, China bound to have a very broad spectrum of comparative advantages. The combination of regions such as Shanghai with a per-capita income of US$ 19.800 and Gansu with a per-capita income of US$ 4.300 has the potential to challenge countries like Colombia in the competition of both skilled and unskilled intense goods as well as in low and relative high technology embedded goods.

Even though China is not yet a high income economy, it seems to conform to almost all definitions of large country as population, area, economy size, trade volume. Apart form the standard large country advantages, it scale effect give to China an important point in capital and technology intensive industries, because the possibility of: first, translating high fixed cost into low unitary cost. Second, benefiting form the increasing returns associated with learning an the creation of knowledge and third is able to overcome externalities associated with increasing return technology (Murphy et al., 1989). The advantage of size, which are maximized by the country's exceptional growth, have attracted an important stream of foreign direct investment, which boost overall investment, bring technology and thus has reduced the barriers to China entering in capital and technology industries.

Therefore, it should also be noted that it is no longer the case that China only poses a threat in labor-intensive or low-tech products. Indeed, the share of high technology products in Chinese exports has increased significantly since 1990 suggesting that China is now internationally competitive in a wide range of products. In that sense, industries which are threatened by China in countries like Colombia, include not only the well known cases of relatively labor-intensive industries such as clothing, textiles, leather and footwear and furniture, but also capital-intensive and relative skill-intensive ones such as iron and steel, aluminum and basic electronics. (Jenkins and de Freitas Barbosa, 2012; Gallagher and Porzecanski, 2008).

According to Hanson (2012) by 2008, the export shares of footwear and toys had declined to 2.4 and 3.5 percent, respectively. Joining shoes and toys among China's top exports are completed computers, with 4.5 percent of total shipments in 2008. Cellphones, TVs, and radio transmitters, were 3 percent of total shipments in 2008, making this category China's third largest. Over time, China is both manufacturing more technologically advanced goods and accounting for a larger share of value added technologically in their production.

China's rapid transition from low-technology to high-technology products represent a challenge in high-income economies that see their competitive advantages in high-tech goods crumble and in developing economies concerned about fall behind in China's technology development.

IV. Data

In this section we describe our data sources and show how the trade between China and Colombia has evolved. We then define and calculate a measure of Chinese import competition that Colombian Plants face at home.

In order to study the impact of Chinese import competition on Colombian Plants performance, we match the trade data with the Colombian Annual Manufacturing Survey or *Encuesta Anual Manufacturera, EAM.* The EAM is conducted by the Colombian Bureau of Statistics *Departamento Administrativo Nacional de Estadistica, DANE*. The EAM, is an unbalanced panel that registers information on all manufacturing establishments with 10 or more employees. Its records include information on output value, number of employees, value of inputs used, energy consumed, value of the stock of capital, value of domestic and export sales and purchases of capital. Given the data availability we are able to cover the period from 2000 to 2012, which covers the scarce trade between China and Colombia in 2000, 2001 and 2002, follow by the Chinese imports expansion after the China accession to the WTO in late 2001, until 2012 as a strategy to ruled out the effect of the free trade agreement between Colombia and United States in force since June of 2012.

Once a plant is included in the survey, it is followed over time until it goes out of business. The data set is an unbalanced panel data of approximately 14,024 plants for the period between 2000 and 2012, which amounts to a total of 103.683 observations. These plants are located in 27 of 32 states in Colombia. Given that each plant belongs to a just one industry category, classified according to the economic activity that they carry out following the *International Standard Industrial Classification, ISIC Rev.3*.[4] We are able to match each plant with the corresponding industry imports data. The trade data used to compute the import competition measure were taken from the *UNCOMTRADE* database, initially the trade data was downloaded as six-digit Harmonized System (HS) which is product-level data and then was converted into its ISIC rev.3 version, which is 4 digit disaggregated industry-level data, by using the official correspondence table from HS96 to ISIC rev.3 available at the United Nations website.[5]

V. Empirical Strategy, Identifying causal effects

i. Chinese Import Penetration in Colombian Industry

A measure of Chinese import competition for Colombian firms was built as the Chinese share of the import penetration for the matched industry, following Bernard et al. (2006):

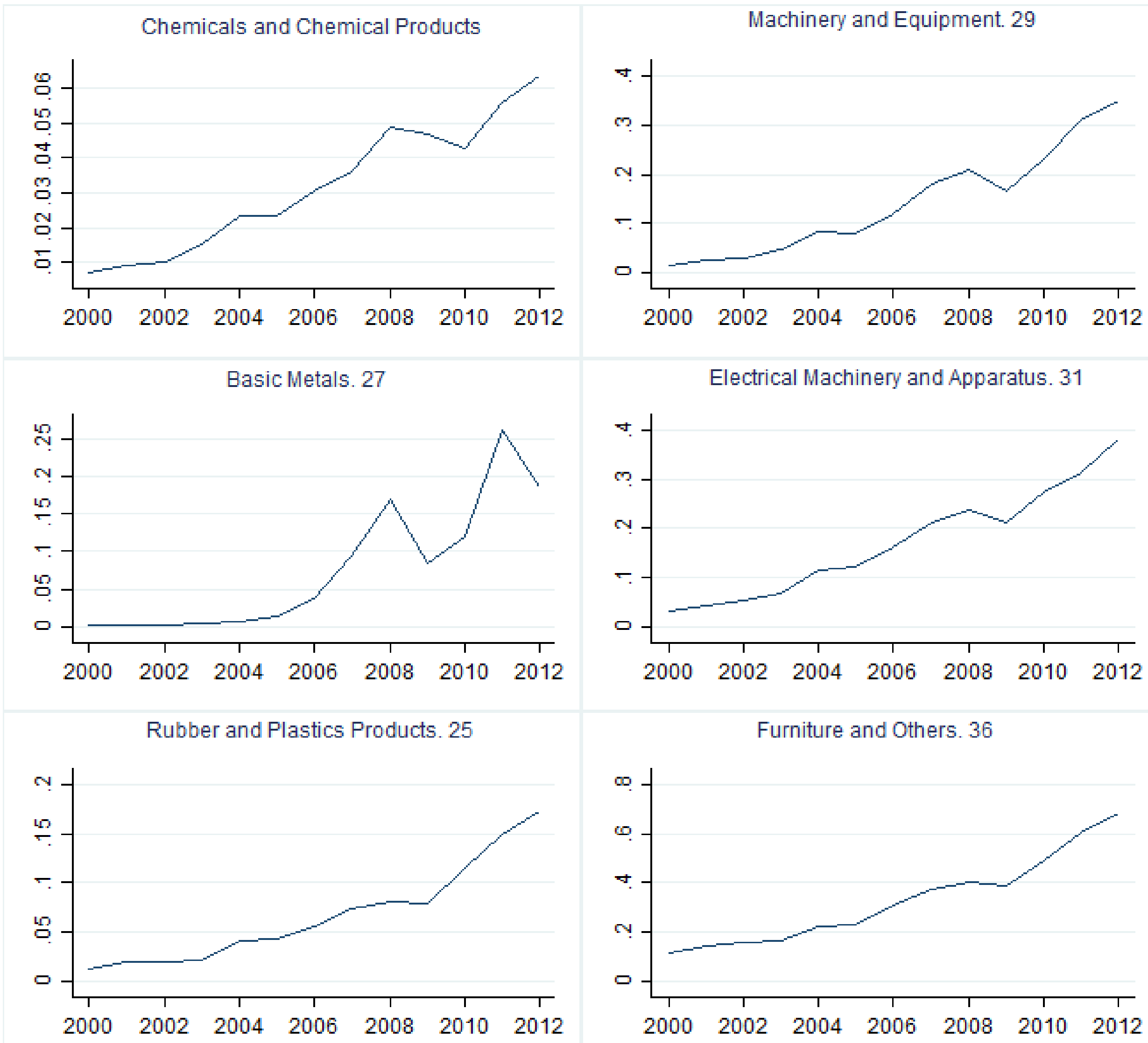
$$IMPCH_{jt} = \frac{M_{jt}^{ch}}{M_{j00} + Q_{j00} - X_{j00}} \tag{1}$$

Where, M_{jt}^{ch} denotes the value of imports of industry j coming from China to Colombia at period t. M, Q and X denote total Colombian imports, production and exports, respectively at the initial year 2000.

[4] DANE Colombia has modified the original ISIC Rev.3 into a Colombian version, therefore in order to match properly each plant with the imports data of its corresponding industry, we first fixed the ISIC Rev.3 with the ISIC Rev.3 adjusted for Colombia, by following the correspondence table at DANE website.

[5] We proceed in this way, because UNCOMTRADE database is the only source of disaggregate trade data for Colombia, specifically was the only way to get four-digit disaggregated trade industry level data.

Figure 2: *Chinese Import Penetration Rate among Selected Colombian Industries*



Source: Author's own calculation. Data comes from UNCOMTRADE and DANE.

Figure 2 and shows the evolution of the Chinese import penetration rate for some manufacturing industries in Colombia for the period 2000-2012. Import penetration rate indicate to what degree domestic demand is satisfied by imports from China. The beginning of 2000s, imports of Colombia from China were relative scare accounting just in Furniture and other industry a modest roughly 10%. However the domestic demand supplied by imports from China exhibited a dynamic increase since 2002, scaling up to almost dominated as a source of imports in the traditional labor-intensive sectors such as clothing, footwear and other manufactures (toys), but also in 2012 its dominance had also shifted to high-technology sectors as electronic and machinery, where Chinese imports accounts almost for the 40% of the Colombian demand for products within this industries.

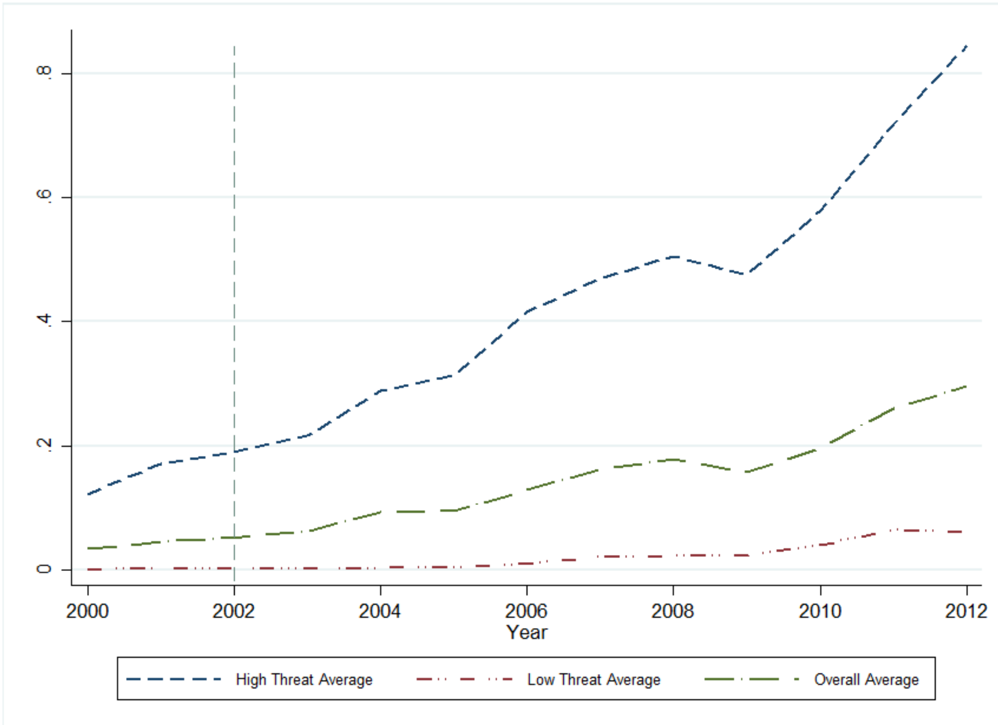
ii. Methodological Approach

Our identification strategy is based on the fact that some of the manufacturing industries are not affected by intensified Chinese imports associated with its accession to WTO as much as sectors with a strong Chinese comparative advantage. Across sector variation in the degree of Chinese competition can be due to structural reasons such as transportation costs, or relative skill-intensity of the production processes. Various reasons for the variation in the Chinese comparative advantage will be reflected in the Chinese import penetration rate. Based on the first and last quartiles of the Chinese share of import penetration in the Colombian market before China's WTO accession as in the initial year 2000, to identify low threat industries where minimum Chinese presence and threat is expected, and high threat industries where a high degree of Chinese competition is expected.

As result, the low threat industries in Colombia at four-digit ISIC Rev.3 disaggregation, are mainly: food products and beverages. Manufacture of builders' carpentry and joinery, sawmilling and planing of wood. Manufacture of pulp, paper and paperboard and corrugated paper, paperboard and of containers of paper. Manufacture of structural metal products, tanks, reservoirs and containers of metal, and steam generators. Manufacture of motor vehicles. Manufacture of other transport equipment. Whereas as high threat industries are Apparel, Footwear, luggage, handbags and the like saddlery and harness. Manufacture of machine-tools, machinery for textile, apparel and leather production. Manufacture of domestic appliances and Manufacture of electricity distribution, electric lamps and lighting equipment. Manufacture of musical instruments, of sports goods, games and toys.[6]

[6] The first quartile of the Chinese of the import penetration rate in 2000 is 0.006. The third quartile of the

Figure 3: *Chinese Import Penetration Rate in Colombia*



Source: Author's own calculation. Data comes from UNCOMTRADE

Figure 3 shows the evolution of the average Chinese import competition rate for High and low threat industries, as well as the Overall manufacturing sector average in Colombia. We exploit both the sectoral variation and the variation across time in the slope, as the figure shows to identify the Chinese competition effect on Colombian Manufacturing firms.

Our empirical model, can be generalized as follows:

$$lnY_{ijst} = \beta_0 + \beta_1 IMPCH_{jt} + \beta_2 X_{ijst} + \beta_3 Ind_{jt} + d_t + State_{st} + c_i + \epsilon_{ijst} \quad (2)$$

where, lnY_{ijt} refers to the plant performance measure (output, employment, average wages, skill intensity) at plant i in industry j at year t.

Chinese import penetration rate in 2000 is 0.071. The sectors that do not belong to any of these groups can then be said to be intermediately exposed to Chinese competition

Vector X includes relevant time varying firm-level controls, these are basically multi-plant and age dummies.[7] Vector Ind_{jt} accounts time varying industry-wide controls. in general these are industry aggregate variables for the matched industries that may affect the demand for a particular manufacturing sector, specifically we included here, the world import penetration rate of the corresponding Colombian industry calculated without the imports from China. d_t and $State_{st}$ are year and state fixed effects added to control for aggregate shocks that may affect the variable of interest across all sectors and states. The standard errors are clustered by each industry in each year to account for correlation of shocks within each industry-year. Given the panel aspect of the data we consider c_i as the unobserved heterogeneity.

A potential concern that arise is the reverse causality problem: Because some factors such as demand or technology shocks for particular products or industries in the domestic market can be correlated with the firm performance and the industry-level Chinese imports. This type of endogeneity bias might work against finding any impact of Chinese competition, because both Colombian and Chinese imports are expected to react to these types of unobservable shocks in the same direction, hence it might cancel the competition effect. Therefore, is reasonable to think that ϵ_{ijst} is correlated with $IMPCH_{jt}$, leading to $E[IMPCH, \epsilon] \neq 0$. The correlation between the independent variables with unobserved factors would bias our results.

To identify causal effects, we need to address the potential reverse causality issue. To address this problem, we use Chinese world export supplies or the worldwide imports from China, as an instrument that is correlated with Colombian imports from China but uncorrelated with the firms outcomes. The instrument IV_{jt} takes the form:

$$IV_{jt} = (CH^{x}_{jt} - CHCOL^{x}_{jt}) \tag{3}$$

Accounting for the China's total supply of products in industry j to the entire world -The worldwide Chinese imports-, minus the Chinese exports to Colombia -Chinese imports of Colombia- in period t.

[7] Since EAM does not report the year when the plant was established, we calculated an age variable according to the number of years that firms have been in the sample since 2000 to have a notion of firm's age.

To be valid our instrument must satisfy two requirements: first, the instrument must be uncorrelated with the error term, $Cov[z, u] = 0$, in other words the instrument must be exogenous. The worldwide Chinese imports must be exogenous from the perspective of Colombia firms as it is expected to be driven by rest of the world and China itself. Second the instrumental variable must be relevant, it must explain our endogenous variable, in our application this requires that our measure of Chinese import competition will partially correlated with the worldwide Chinese imports. Therefore, the instrument should capture the supply side driven growth component of Chinese imports independent from the Colombia demand factors, given that the causal relationship between the instrument and import penetration measure arises from the correlation between Colombia's imports for product of industry j and China's comparative advantage in that industry.

Formally, if the excludability and relevance conditions are met, then the instrumental variable estimator is a consistent estimator and it will indicate that neither endogeneity nor unobserved variable are driving our results and we will able to identify the causal effect of Chinese import competition on the Colombian plants performance.

VI. Results

We begin by examining the first-stage relationship between our instrument and the endogenous variable, the Chinese Import penetration rate. Table 1 contains the result from three models, the first one, a model with the completed controls set that we use to get our main results, the second model including a less substantive control set.[8] The results indicate that the Chinese worldwide imports is a good instrument for the Chinese import penetration rate in Colombia.

All two coefficients measuring the relationship between these two variables are significant at $p < 0.01$ level. Regarding to the relevance and validity of instruments, The underidentification test, Kleibergen-Paap LM statistic, testing whether the excluded instrument is relevant and the equation is identified, rejected the null hypothesis, indicating that the matrix is full column rank and the model is identified. The weak identification

[8] We consider the following plant and industry controls. Rest of the world import penetration rate. A dummy variable referring the case whether the firm is a multi-plant and the age dummies young and old.

test provide by the Cragg-Donald Wald F statistic, in both models was larger enough to suggest that the instrument performs well. Moreover, the weak-instrument test[9] checking the significance of the endogenous regressors in the structural equation fail to reject the null hypothesis that the coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and, in addition, the orthogonality conditions are valid.

All the followings tables presents the second-stage results for the IV model in equation (2) as well as some extensions that explore the heterogeneity effect of Chinese import competition on Colombian manufacturing plants performance. Such heterogeneity analysis include interactions between the Chinese import penetration rate and two age dummies are constructed according to the number of years that plants have been in the sample since 2000. The plant i belongs to the young group, if has been in the sample for less than 6 years. The firm i, belongs to the old group if it has been in the sample for more than 6 years.

Moreover, for the heterogeneity analysis we considered different plant size groups defined by total workforce and by market share within the same 4 digit ISIC industry. In order to define these groups we proceed as following: we considered the total workforce and the market share distribution of plants for the initial year 2000, then we calculated the quantiles for each distribution in that year. We defined the categories Big, for those plants at the top 20% of the total workforce distribution at the year 2000 and small, for those plants at the first and second quantile of the same total workforce distribution. Similarly, in the case of the market share, we defined a High group for plants at the top 20% of the market share distribution for its specify industry in the initial year and a Low group for those plants at the first and second quantiles of this market share distribution.

Furthermore, the Chinese competition measure is also interacted with several variables of interests at firm level such as: productivity, skilled, unskilled ratio and capital-labor ratio, to see if trade between the Colombia and China has a disproportionate effect on any particular type of manufacturing plants in Colombia.

[9] The Anderson-Rubin Wald test and the Stock-Wright LM S statistic.

i. First Order Effects

We first start analyzing the effects Chinese import competition on the followings Colombian manufacturing plants: output, sales, value added, employment, and wages. Subsequently, the analysis will focus on the dynamic effects of the competition on the evolution of manufacturing firms in Colombia, identifying its impact on productivity, skill intensity, entry and exit.

i.1 Firms Output

The effects of Chinese import competition on Colombian manufacturing plants output are presented in table 2. Given the richness of our data we are able to analysis industrial output and gross output, for each plant in our sample. In panel A, the dependent variable is the logarithm of gross output, whereas in panel the dependent variable is the logarithm of industrial output. In column 1, the coefficients of the Chinese share of import penetration rate are negative and significant at 1 percent level for both panels, suggesting that for an average manufacturing plant, one standard deviation increase in the Chinese share of import penetration rate (11 percentage point increase) is associated with: a 5.44 percentage point decrease in log gross output and a 5.36 percentage points decrease in the of industrial output. Such findings suggest, that Chinese imports are reducing demand in the domestic market for goods produced in Colombia and therefore, displacing domestic production of manufacturing plants.

Columns 2 and 3, are referring to the heterogeneity that might exist between manufacturing plants regarding to the number of years that they have been active in the market. The results indicate that young firms are more negative affected by Chinese import competition comparing to the relative older ones, indicating the age of the plant may influence the way in which plants' output are affected by international import competition. Moreover, the results in column 4, shows that firm with higher productivity are able to mitigate the negative impacts on output derived from increasing Chinese import competition.

Regarding to the differences across big and small plants measuring by the total number of workers. We find that, differentiated effect of Chinese import competition on big and small firms. For the small plants group (plants in the first and second quantile of the total workers distribution at the initial year) the Chinese import competition have a negative affected both, the industrial and gross output. One standard deviation increase in the Chinese import penetration rate, is associated with a 19 and 20 percentage points decrease in the log of gross and industrial output, respectively. Whereas, for the big plants group (plants at the top 20% of the total workers distribution at the initial year) the effect of Chinese import competition on output is positive, one standard deviation in our measure of the penetration rate, will increase the gross and the industrial output of this type of plants by 56 percentage points compared with others. Similar results are suggested, when we analyze the heterogeneity of manufacturing plants by market share within its active disaggregated industry. Plants at the higher quantile of the market share distribution within its industry, were capable to increase their output, whereas, for plants at the lower quantiles of the market share, one standard deviation increase in the Chinese import penetration rate, is associated with a decrease of 31 percentage points in the log of its gross and industrial output.

i.2 Sales and Value Added

The table 3 contains the estimated impact of Chinese import competition on total sales (panel A) and value added (panel B) in manufacturing plants. The results, in column 1 of both panels, suggest that, for an average plant, there not a significant impact of increasing Chinese competition on sales, but a negative effect of China competition is found in the case of value added. A 10 % increase in the Chinese import penetration rate, reduce 5% the log of value added of an average plant. The heterogeneity analysis shows a disproportionated effect of Chinese import competition between small and big plants, measure by both number employees and industry market share. In particular, while, top Big plants still increase their sales and value added even in presence of intensified import competition, smaller plants display a significant decrease in sales and value added. Among small plants, the decline in sales is estimated around 18-28 percentage points. On the other hand, the decline in valued added falls between 18 and 23 percentage points, for this type of plants; both effects in response to a 10% increase in the Chinese import penetration rate. Furthermore, the results evidence that higher productivity reduces the negative effects of Chinese import competition on plants' sales and value added. These findings are similar to those estimated by Utar and Ruiz (2013) in the Mexican case.

To complete the analysis regarding the effect of China competition on sales and value added, we consider different types of plants regarding their exporting or importing behavior. The exporter category is defined as a dummy variable that takes the value of 1 if the plant reported positive sales abroad, and 0 otherwise in a specify year. Likewise, importer category was take the value of 1 if plant reported positive share of foreign origin in their output. Columns 2 and 3, show the interaction effect of Chinese import competition among exporter and importer plants. The results indicate that rising import competition have negative affected the sales and value added among exporters. The coefficients indicates that, a 10 percentage points increase in Chinese competition proxy by Chinese import penetration rate, is associated with a 4 percentage points decrease of in the log of total sales for a exporting plant, compare to no exporters and with a 8 percentage decrease in the log of value added of exporting plants. These results indicate evidence to suggest that Chinese import competition might represent a challenge for Colombian non-traditional exporting manufacturing plants in international markets.

i.3 Plants Employment

Table 4 presents the estimation results of impact of Chinese import competition on both direct (panel A) and total employment (panel B) in manufacturing plants in Colombia. Column 2 and 3, suggest that both direct workers and total employment[10] in younger plants has been more negative affected by Chinese import competition relative to the older ones. Moreover, workers in plants exhibiting higher productivity tend to be less exposed to lose their job due to import competition, but it does not guarantee that productive plants have experience employment cuts. On the other hand, the estimation results in

[10]This variable is originally reported by EAM, it considers all type of hired workers that a plant has. In addition to the part and full time direct workers, this category includes: Temporal employees who have a permanent contract of employment with a temporary agency, interns and apprentices.

column 5, indicate that in capital-intensive plants, the employment has increase and subsequently, the employment for labor-intensive plants have decrease under intensified Chinese import competition proxy by the Chinese import penetration rate in Colombia. Specifically, one standard deviation increase in the Chinese import penetration rate, translate in 5.6 and 2 percentage points increase in the log of direct and total workforce, respectively, among capital-intensive plants.

The heterogeneous results among different types of plants size by both market share and workers size, evidence a disproportionate effect of Chinese import competition on manufacturing plants in Colombia. In the case of big plants defined by the employment size, the results suggests that, a one standard deviation increase in the Chinese import penetration rate, will increase the log of direct and total workforce by 39 and 46 percentage points, respectively. Moreover, plants at the top 20% of the market share within its industry, facing the same change in the Chinese import competition will increase indicate, an increase in the log of direct and total workforce of 22 and 27 percentage points, respectively. Contrary, to the big size plants, employment in small plants relative the number of employees and their market share, is found to be negatively affected by import competition. The results suggests that among small firms in terms of industry market share, one standard deviation increase in the Chinese import penetration rate is associated with a 15 and 17 percentage points decline in the log of direct and total workers for this type of manufacturing plants. Moreover, the magnitude of employment losses among small plants defined by number of employees, rises to a 17.6 and 23.1 percentage points decrease in the log of direct and total workers employment, respectively.

In order to deepen the analysis of the effects on Chinese import competition on manufacturing plants employment, we interact our import competition measure with the share of skilled and unskilled workers over total direct workforce. By doing this we are able to identify, whether employment losses are happening among skill-intensive or unskilled-intensive manufacturing plants. Columns 10 and 11, in table 4 containing the results of this interaction term. The estimations for direct workers in panel A, suggest that intensified the Chinese import competition, slightly reduced the employment of direct workers in more skilled-intensive plants and it has marginally increased the employment of direct workers in relative unskilled-intensive plants. Specifically, one standard deviation in the Chinese import penetration rate, reduce the log of direct workers by 9 percentage points, in relative more skilled-intensive plants, compared to the less skilled-intensive ones. Moreover, the same effect of increasing Chinese import competition, slightly increase the employment of direct workers among more unskilled-intensive plants by 2.2 percentage points in the log of this variable. On the other hand, in the case of total workforce, we find that the same pattern holds, in the sense that, Chinese import competition have mixed effects on total employment for different skill-using manufacturing plants. The results are suggesting that Chinese import competition negatively affects the total employment in relative more skilled-intense plants, whereas, for the relative unskilled-intensive ones, intensified import competition increase the total number of workers. However, the magnitude of this effect rises for the case of total workers. We find, that for skilled-intensive plants, one standard deviation increase in Chinese import penetration rate, reduces the log of total workforce by 41 percentage points, while, the same 11 percentage points increase in the Chinese import penetration rate, increment 22 percentage points the log of total workers among relative more unskilled-intensive plants. Such phenomenon might be explained, given the 2002 Labor Reform in Colombia.[11] Plants were able to reduce labor cost by hiring low-skill workers through new hiring modalities as through an outsourcing agency, meaning given the labor reform, manufacturing plants started to outsourced domestically unskilled workers, as a strategy to reduce labor cost in presence of increasing import competition.

Since, our results suggest that intensified Chinese import competition have reduce the employment in labor-intensive manufacturing plants compared to the capital-intensive ones and considering the previous analysis, we argue that employment losses within labor-intensive plants, is mainly driven by the negative impact of Chinese import competition on the number of total workers in relative more skilled-intensive plants, rather than in unskilled-intensive plants. Such phenomenon is explained by the fact that China productive structure rapidly moves up the value chain, evidenced by the increasing

[11] The aim fo this reform was: first, reduce and increasing the flexibility of non-wage costs. Second, increasing wages' flexibility. Third, introduce a wider variety of hiring modalities.

technological sophistication of China's exports (Chandra et al., 2013). Emerging Chinese competition respect to skill and relative more technology-intensive production, is expected to produce negative effects on employment and output in Colombian plants active in more skilled-intensive industries, since these plants may face more difficulties in maintaining and expanding their export markets and may also experience increasing import penetration in the domestic market.

i.4 Average Wage

The table 5 contains the results measuring the impact of rising Chinese import competition on Colombian manufacturing plants. The results indicate that, for the average manufacturing plant, one standard deviation increase in Chinese the import penetration rate, reduced the log of average wage by roughly 2 percentage points. The negative effect of import competition on average wage is statistically significant regardless of plants relative age. Moreover, higher productivity and higher capital-intensity, seems to soften the negative impact of Chinese import competition on average wages of workers in this types of plants, although these characteristics are not enough to overcome the entire negative impact magnitude.

In columns 5, 6, 7 and 8, we find a heterogeneous effect of increasing Chinese import competition on average wages among small and big plants, defined by both market share and number of employees. Big plants at the top 20% of the workers and market share distribution in the initial year, have increased the average wage. Contrary, small plants at the first and second quantile of these distributions have reduce average wage due to heightened Chinese import competition. Specially in the case of big and small plants defined by the number of employees, we find that one standard deviation increase in the Chinese import penetration rate is associated with a increase of 12 percentage points in the log of average wages for Big plants, compared with a decline of 5 percentage points among the smalls. The same difference holds for the case of big and small plants categorized by industry market share.

This analysis shows that, whereas for big plants the positive effect of firm-size on workers' wages holds, despite of Chinese import competition. Workers' wages in small manufacturing plants have been negatively impacted by increasing import competition from China.

Furthermore, columns 10 and 11, present a disproportioned effect of Chinese import competition on average wages in relative skilled and unskilled using plants. The results indicate that average wages in relative more skilled-intensive plants are positive affected by increasing import competition. Whereas, heightened Chinese import competition negatively affect the average wage in relative more unskilled-intensive plants. The coefficients indicate that one standard deviation increase in the Chinese import penetration rate, increase in 12 percentage points the log of average wage among relative skilled-intensive plants. While the same increase in the Chinese import competition measure, decrease in 10.5 percentage points the log of average wages fur relative unskilled-intensive Colombian manufacturing plants, such finding is mainly marked by big size plants. These results are related to those found by Ebenstein et al. (2014) who examined the impact of import penetration on wages both within the manufacturing sector and across sectors and occupations. They found that workers in occupations most exposed to import penetration experience slower wage growth.

According to the literature, one line of explanation for the increase in the skill premium, focuses on the pattern of protection prior to trade liberalization –and therefore prior to import competition– in many developing countries, and the skill intensity of the sectors that were impacted the most by trade opening reforms. Several studies argued that, prior to trade reform, the unskilled labor-intensive sectors were the most protected. Such protection pattern has been documented in Mexico (Robertson, 2004), Morocco (Currie and Harrison, 1997), and Colombia (Attanasio et al., 2004).[12] These studies showed that it was the wage in unskilled-intensive sectors that were impacted the most by tariff cuts. Given this evidence, the increase in the skill premium is explained by the prediction derive from Stolper-Samuelson theorem. Since, trade liberalization was concentrated in

[12] However, the reason why Governments in developing economies abundant in unskilled labor, decided to protect unskilled-intensive sectors, when the pattern of comparative advantage would have suggested otherwise, is not clear. One potential answer is that the protection patterns reflected political economy considerations, rather than related to comparative advantage .

unskilled-intensive sectors, the economy wide return to unskilled labor should decrease.

Therefore, in the spirit of Stolper-Samuelson forces, plants substitute away from skilled labor with the rising skill premium, as it was observed in the previous employment section, while the number of direct and total workers were decreasing in relative skilled-intensive plants due to higher Chinese import competition. Direct and total employment have increased among relative unskilled-intensive plants.

ii. Dynamic Effects

ii.1 Productivity

Before to analyze the effects of Chinese import competition on plants' productivity. We explain, how the plants' productivity was estimated.[13]

Considering the following Cobb Douglas production function for plant i at time t:

$$y_{it} = \alpha + w_{it}\beta + k_{it}\gamma + \omega_{it} + \epsilon_{it} \tag{4}$$

where y_{it} is the log of value added , w it is a $1J$ vector of log free variables (labor) distinguished between skill and unskilled labor and k it is a $1K$ vector of log state variables (capital). The random component ω it is the unobservable productivity or technical efficiency and ϵ it is an idiosyncratic output shock distributed as white noise. According to Olley and Pakes (1996), we assume that productivity evolves according to a first-order Markov process. We deflected nominal values using its corresponding available deflector. In that sense, the variables: *value added* was deflected by the manufacturing sector PPI. In the case of the capital variable: *total fixed assets* was deflected using the capital goods PPI.

Transforming the above production function into logarithms allows linear estimation. However, OLS estimation is biased, by the problems of endogenity of the input demand and by the self-selection induced by exit behavior. The endogenity problem arises because current input choices are determined in some extent by the firms' belief about likely

[13] Although, the plant level productivity estimation implemented here is quite standard, we wanted to clarified how we got the dependent variable in this section the log TFP. The TFP estimation is explained in detail in the appendix.

productivity level when those inputs will used; then profit maximization of the firm implies that the realization of the error term of the production function is expected to influence the choice of factor inputs. This means that the regressors and the error term are correlated. Levinsohn and Petrin (2003) offer an estimation technique that is very close in spirit to the Olley and Pakes approach. Instead of investment, they suggest the use of intermediate inputs as a proxy rather than investment. Typically, many datasets will contain significantly less zero-observations in materials than in firm-level investment. Moreover, the variable *intermediate consumption* was deflected using the intermediate consumption PPI.

Most available plant-level data do not contain plant-level physical quantities and prices, as happening in this case. This gives rise to the concern that markups may be captured by the productivity measure as they are also expected to respond to heightened competition. In this case, however, markups should go down as competition intensifies more so for those plants facing the toughest competition, causing downward bias in the estimates.

Productivity results are presented in Table 6. The coefficient in column 1 indicates that one standard deviation increase in the Chinese import penetration rate, is associate with a decrease of 3 percentage points, in the log of TFP, for an average manufacturing plant. Among, relative younger plants, the magnitude of this effect might represent a 7.7 decrease in the log of TFP, comparing to the relative older plants. Moreover, columns 5-8, present evidence to suggest a heterogeneous impact of Chinese import competition on plants' productivity regarding the size. The results, shows that whereas for big size plants, there exist a positive effect of increasing Chinese import competition on plants productivity (measure between 20-22 percentage points increase in the log of TFP, in case that the Chinese import penetration ratio increase one standard deviation) this effect fades out for small size plants, even it might exhibit a not significant negative effect.

We want to point out that, this study analyzed specifically the effect of recent increasing Chinese import competition on Colombian manufacturing plants productivity. Contrary, to previous studies, related to the effect of trade reforms in Colombia on manufacturing plants productivity, as for instance, Eslava et al. (2004), who using a panel of Colombian manufacturing firms in the period 1982-1998, argued that the trade reforms appears to increase average plant productivity by both forcing to exit less productive plants and by increasing productivity among continuing plants.

ii.2 Plant Exit

A probit model with instrumental variable is used to analyze the impact of Chinese competition on plants exit. The exit variable, $x_i t$ is a dummy variable that takes 1 if plant i exits at period $t + 1$.[14] In these regressions aggregate shocks and industry specific factors are controlled for using the full set of state by year and industry fixed effects. The results, presented in Table 7, shows significant effect of Chinese competition on manufacturing plants exit. Column 1, indicate that an increase of 6 percentage points in the Chinese import penetration rate, increases 9 percentage points the exit probability for an average plant.

On the other hand, we find that relative younger plants are more likely to shutdown, due to tougher Chinese import competition, compare to relative older plants. Among, younger plants an increase of 6 % leads to 28 % increase in the probability of plant exit. This results is explained by theoretical models in which firms learn about its efficiency (Jovanovic, 1982). In such a case, older firms have more accumulated knowledge and are more likely to survive.

The interaction between Chinese import penetration rate and plant productivity, in column 4, reveals that increasing imports from China are associated with a higher exit probability for low productivity plants. In other words, plants with higher productivity are more likely to survive and do not exit the market in the wave of heightened Chinese import competition.

Furthermore, columns 5-8, present the heterogeneous analysis of the effects of Chinese import competition on different plant sizes. The results suggest a significant negative effect of Chinese import competition on exit among big plants, measured by both market share and number of workers. We find that, big plants, are less likely to exit the market in presence of Chinese import competition. The results are consistent, with previous

[14] For details see Appendix.

studies analyzing the impact of Chinese import competition on domestic manufacturing plants shutdown. For instance, Utar and Ruiz (2013) studied the effect Chinese import competition in the U.S market that Mexican Maquiladoras are facing, finding a significant and negative relationship between exit and size as well as between exit and productivity. Moreover, for U.S. manufacturing industry, Bernard et al. (2006) find evidence that low-wage countries' import penetration increases plants' death in the U.S. manufacturing industry. Our findings are fairly consistent with previous empirical evidence for productivity, age and size. In the sense that, plant exit is negatively associated to plant size, age and total factor productivity.

ii.3 New Plants

To properly analyzed whether the Chinese import competition have affected the potential entry decision that a specific plant might take. We aggregate the plant-level data into a broad 4 digit ISIC.Rev.3 industry-level dataset. As a way provide much insight about the number of realized entries within an specif manufacturing industry. Therefore, in this section the following the equation is estimate:

$$Entry_{jt} = \beta_0 + \beta_1 IMPCH_{jt} + WIMPCH_{jt} + \sum_t \delta_t^y + \epsilon_{jt} \tag{5}$$

Where $Entry_{jt}$ is the total number of entrants in industry j at period t. The year dummies in this regression will control for aggregate shocks, such as exchange rate, that may affect the entry decision of manufacturing plants in the same way across sectors as it affects the relative production costs between Colombia and China. To aisle the effect of intensified Chinese import competition we also control for $WIMPCH_{jt}$ the rest of the world import competition.

If intensified Chinese competition discourages entry of new manufacturing plants in Colombia, we expect β_1 to be negative. Since our dependent variable denotes the number of total new entries in the industry j for a given year. We consider the Poisson regression as a the natural method to estimate equation 5. The estimation results are shown in table 8. A negative and significant effect of the Chinese import penetration is found on manufacturing plants market entry. When the import penetration rate is added in column

2, enables us to suggest that this effect is especially true for Chinese import competition. The results suggest that intensified Chinese import competition is found to discourage manufacturing plants entry in Colombia.

ii.4 Skill Intensity

In this section we analyze, the evolution of the skill intensity in manufacturing plants in Colombia. The average skill intensity is defined as the ratio of administrators and technicians to unskilled workers. This definition of skill intensity is similar to the one used by others authors, and it assumes basically, that non-production workers are more qualified than production workers.

Looking at the average skill intensity of entrants, we identify that average skill intensity slightly decrease, from 0.38 in 2001 to 0.37 in 2012. Since the mean size of entrants is unchanged in the 2001-2012 period, this small decrease among entering Plants is not driven by size changes. On the other hand, for continuing plants, we find that average skill intensity, presents a moderate increase from 0.36 to 0.39 for the period of 2000-2012.

Thoenig and Verdier (2003) and Thesmar and Thoenig (2000) both show theoretically that increased competition can lead to a change in within firm organization that biases towards skilled labor. Moreover, Utar (2014) shows that employment of Danish Textile firms decline significantly in response to the MFA quota abolishment for Chinese products. Finding that the decline in employment happens mostly among low-skilled workers, leading to compositional changes in the organization of the Danish firms towards higher skill intensity. Recently, Mion and Zhu (2013) argued that import competition from China accounts for 42% of the within firm increase in the share of skilled workers in Belgian manufacturing firm. Additionally, Utar and Ruiz (2013) find that Chinese competition for the U.S market triggers an increase in skill intensities for the Mexican maquiladoras case.

Table 9, present the estimation results of the effect of Chinese import competition on skill upgrading in manufacturing plants in Colombia. The results suggest, that for an average plant there is not effect of skill intensity derived from increasing Chinese import competition. In contrast to previous plant-level evidence, for manufacturing plants in Unites States, Mexico, Belgium, Denmark among others, we do not find evidence to suggest that manufacturing plants in Colombia have increase the skill intensity in response to import competition from China. However, such no skill bias effect, was also found by Álvarez and Claro (2009) for the Chilean manufacturing firms. Although, the recent work of Fieler et al. (2018), find that trade liberalization in the decade of 90's in Colombia have induced to skill upgrading in manufacturing firms, we suggest that this overall trade openness effect, is not evidenced in the particular case of increasing import competition after China's accession to the WTO, in the last decade.

Furthermore, the heterogeneous analysis of the impact of Chinese import competition on skill intensity among deferent types of plants, shows that the evidence of not existing skill upgrading in response to import competition from China, holds regardless size or relative age of manufacturing plants. However, column 4 and 7, indicate that Chinese import competition triggers skill upgrading only in more productive and more capital-intensive plants. Specifically, we find that one standard deviation increase (11 percentage points) in the Chinese import penetration rate, increases 6.6 percentage points the log of skill intensity among more productive plants. On the other hand, the same change in the Chinese import competition, increases 8.3 percentage points the log of skill intensity in more capital-intensive plants, compare to the less capital-intensive ones. This is explained, since plants with relatively less sophisticated technologies and less productive are more exposed to competition from China and probably produce products that are more likely to be replaced by Chinese products, while others plants with already higher productivity and relative capital-intensive, are more likely to upgrade their production with more emphasis on skilled-intensive goods, in order to cope with increasing Chinese import competition.

VII. Concluding Remarks

Using plant-level data, this paper analyze the impact of competition import from China on the performance and evolution of manufacturing plants in developing economies as Colombia. We exploit the exogenous intensification of the import penetration by China around the time of its accession to WTO and the fact that not all plants are exposed to the competition to the same degree, as identification strategy. Moreover, using a valid instrumental approach, we are able to present unbiased results.

We find that manufacturing plants in Colombia are negatively affected by Chinese import competition. Plant output, employment entry and survival probabilities are found to be responding negatively to increasing Chinese competition. While there is no evidence found that Chinese competition cause skill upgrading among manufacturing plants. More productivity and relative capital-intensive plants, are more likely to upgrade their skill production structure to face increasing Chinese import competition. Furthermore, Chinese import competition negatively affects the total employment in relative more skilled-intense plants, whereas, for the relative unskilled-intensive ones, intensified import competition increase the total number of workers, meaning that domestically, manufacturing plants in Colombia are outsourcing unskilled workers.

Since plant have different competitive capacity to compete with imports. The results of the heterogeneity analysis indicate that smaller and less productive plants are in greater extent negative affected by Chinese import competition. On the other hand, we find evidence to suggest that more productive and larger domestic firms may handle better the impact of increasing imports competition, due to their generally more sophisticated technologies and business processes.

The analysis presented in this paper, goes beyond the effect on individual companies and industries to raise concerns over the broader systemic effects of the rise of China on countries like Colombia. Since the negative impact of Chinese competition can be related to the following aspects. First, the possible "de-industrialization" of the economies as local industrial production is displaced by Chinese imports. Second, the rapid movement of China up the technological ladder from labor intensive low tech products such as shoes, textile and toys to more sophisticated products such as electronics and machinery, makes it more difficult for countries like Colombia to upgrade their own industries and tends to trap them in less dynamic industrial sectors. Finally, the combined effect of surging Chinese demand for commodities and intense competition from Chinese manufactured goods in export markets might contributed to a concentration of the basket exports towards primary products as for instance, crude or precious metals, increasing the country dependence on primary commodities revenues, deepen the existing problems associated with dependence on primary products.

Although increasing Chinese import competition present a negative impact for manufacturing plants performance in Colombia, it seems that for policy markers and rent seeking governments, these negative impacts are outweighed by the gains from trading commodities with China and the benefits for consumers, who can have access to Chinese products of increasing quality and technology with relative good prices. We consider that such dynamics might trigger growth in others sectors as commerce, in developing economies like Colombia.

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Tables and Figures

Table 1: *First Stage IV Results*

Variables	(1) CH Import Competition	(2) CH Import Competition
Instrument	0.029***	0.028***
	(0.001)	(0.001)
Year Fixed Effects	✓	
Firm and Industry Controls		✓
Firm Fixed Effects	✓	✓
Kleibergen-Paap LM statistic (p-value)	1301.3 (0.00)	1338.8 (0.00)
Cragg-Donald Wald F statistic	2581.2***	2672.6***

Robust standard errors in parentheses, clustered by each industry and year.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2: *The Impact of Chinese Competition on Plants Gross and Industrial Output*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Dependent variable: log Gross Output									
IMPCH	-0.496***	-0.156	-1.791***	-22.88***	0.857***	-0.708***	1.318***	-0.896***	1.646***
	(0.138)	(0.170)	(0.250)	(.508)	(0.162)	(0.153)	(0.438)	(0.165)	(0.376)
IMPCH*I(young)		-1.635***							
		(0.288)							
IMPCH*I(Old)			1.635***						
			(0.288)						
IMPCH*I(logTFP)				4.665***					
				(.099)					
IMPCH*I(Capital-Labor Ratio)					-1.101***				
					(0.0426)				
IMPCH interacted by workers size									
IMPCH*I(Big top 20%)						5.864***			
						(1.405)			
IMPCH*I(Small)							-3.098***		
							(0 .724)		
IMPCH interacted by Market Share									
IMPCH*I(High Market Share top 20%)								4.384***	
								(0.843)	
IMPCH*I(Low Market Share)									-4.505***
									(0.696)
Observations	89,774	78,212	89,465	89,465	77,939	89,465	89,465	89,465	89,465
Number of firm_ID	12,111	10,939	12,099	12,099	10,924	12,099	12,099	12,099	12,099
Cragg-Donald Wald F statistic	1971***	813.3***	813.3***	911.2***	725***	254.5***	253.9**	164.3***	162.2***
Panel B. Dependent variable: Log Industrial Output									
IMPCH	-0.489***	-0.154	-1.772***	-22.28***	0.858***	-0.697***	1.311***	-0.883***	1.625***
	(0.138)	(0.170)	(0.249)	(0.498)	(0.162)	(0.153)	(0.438)	(0.165)	(0.377)
IMPCH*I(young)		-1.618***							
		(0.287)							
IMPCH*I(Old)			1.618***						
			(0.287)						
IMPCH*I(logTFP)				4.540***					
				(0.0972)					
IMPCH*I(Capital-Labor Ratio)					-1.101***				
					(0.0426)				
IMPCH interacted by workers size									
IMPCH*I(Big top 20%)						5.685***			
						(1.399)			
IMPCH*I(Small)							-3.157***		
							(0.723)		
IMPCH interacted by Market Share									
IMPCH*I(High Market Share top 20%)								4.298***	
								(0.843)	
IMPCH*I(Low Market Share)									-4.543***
									(0.698)
Number of Observations	89,774	89,461	89,461	83,607	77,935	89,461	31,160	89,461	31,156
Number of Individuals	12,111	12,098	12,098	11,987	10,923	12,098	6,208	12,098	6,207
Cragg-Donald Wald F statistic	206.1***	102.9***	103.1***	60.9***	60.2***	60***	67.9***	68.2***	103.1***

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias. All estimations include by year state fixed effects and firm fixed effects. By state by year fixed effects are partial led out.

Table 3: *The Impact of Chinese import Competition on Manufacturing Plants Sales and Value Added*

	Panel A. Dependent Variable: Log Sales								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IMPCH	-0.218	-0.0652	-0.068	-20.05***	1.167***	-0.398***	1.543***	-0.535***	1.791***
	(0.139)	(0.146)	(0.206)	(0.470)	(0.164)	(0.153)	(0.438)	(0.164)	(0.388)
IMPCH*I(Exporter)		-0.392**							
		(0.191)							
IMPCH*I(Importer)			-0.080						
			(0.141)						
IMPCH*I(logTFP)				4.106***					
				(0.0916)					
IMPCH*I(Capital-Labor Ratio)					-1.109***				
					(0.0426)				
IMPCH interacted by workers size									
IMPCH*I(Big top 20%)						5.405***			
						(1.388)			
IMPCH*I(Small)							-3.375***		
							(0.713)		
IMPCH interacted by Industry Market Share									
IMPCH*I(High Market Share top 20%)								3.597***	
								(0.818)	
IMPCH*I(Low Market Share)									-4.660***
									(0.723)
Observations	88,274	88,274	88,274	82,797	77,085	88,274	30,961	88,274	30,958
Number of firm_ID	12,009	12,009	12,009	11,904	10,843	12,009	6,188	12,009	6,187
Cragg-Donald Wald F statistic	2142.3***	342.8***	346.2***	135.9***	165.7***	78.2***	84.1***	97.4***	77.3***
	Panel B. Dependent Variable: Log Value Added								
IMPCH	-0.527***	-0.371**	-0.401**	-46.95***	0.920***	-0.761***	1.320***	-0.963***	1.199***
	(0.162)	(0.173)	(0.177)	(0.894)	(0.189)	(0.180)	(0.486)	(0.192)	(0.443)
IMPCH*I(Exporter)		-0.441***							
		(0.209)							
IMPCH*I(Importer)			0.052						
			(0.359)						
IMPCH*I(logTFP)				9.675***					
				(0.179)					
IMPCH*I(Capital-Labor Ratio)					-1.194***				
					(0.0478)				
IMPCH interacted by total workers size Groups									
IMPCH*I(Big top 20%)						6.328***			
						(1.636)			
IMPCH*I(Small)							-3.188***		
							(0.763)		
IMPCH interacted by Industry Market Share									
IMPCH*I(High Market Share top 20%)								4.717***	
								(0.938)	
IMPCH*I(Low Market Share)									-3.517***
									(0.813)
Observations	89,772	89,463	89,463	83,611	77,938	89,463	31,158	89,463	31,154
Number of firm_ID	12,111	12,099	12,099	11,988	10,924	12,099	6,208	12,099	6,207
Cragg-Donald Wald F statistic	2289***	545.2***	524.1***	97.1***	102.5**	88.6***	92.7***	121.9***	156.4***

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. All models included Firm Fixed Effects and by State-Year fixed effects.For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 4: *The Impact of Chinese Import Competition on Employment*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Panel A. Dependent variable: Log Direct Workers											
IMPCH	-0.111	0.0657	-0.762***	-4.150***	4.354***	-0.234*	1.476***	-0.302**	0.946***	0.207	-0.672***
	(0.136)	(0.157)	(0.221)	(0.284)	(0.199)	(0.141)	(0.383)	(0.149)	(0.355)	(0.180)	(0.223)
IMPCH*I(young)		-0.828***									
		(0.259)									
IMPCH*I(Old)			0.828***								
			(0.259)								
IMPCH*I(logTFP)				0.831***							
				(0.051)							
IMPCH*I(Capital-Labor Ratio)					-3.844***						
					(0.101)						
IMPCH interacted by workers size											
IMPCH*I(Big top 20%)						3.794***					
						(1.147)					
IMPCH*I(Small)							-3.575***				
							(0.652)				
IMPCH interacted by Market Share											
IMPCH*I(High Market Share)								2.306***			
								(0.692)			
IMPCH*I(Low Market Share)									-2.328***		
									(0.618)		
IMPCH*I(Skilled Workers)										-0.879***	
										(0.293)	
IMPCH*I(Unskilled Workers)											0.880***
											(0.293)
Observations	78688	78,688	78,688	73,746	77,939	78,688	25,956	78,688	25,952	74,341	74,341
Number of firm_ID	10,982	10,982	10,982	10,889	10,924	10,982	5,366	10,982	5,365	10,936	10,936
Cragg-Donald Wald F statistic	4007***	765***	739.2**	87.5***	98.4***	374.2***	77.1***	73.8***	127.7***	143.4***	156.8***
Panel B. Dependent Variable: Log Total Workforce											
IMPCH	-0.093	0.107	-1.026***	-3.114***	1.300***	-0.226**	1.462***	-0.329***	1.051***	2.222***	-3.783***
	(0.101)	(0.126)	(0.180)	(0.230)	(0.121)	(0.111)	(0.328)	(0.121)	(0.295)	(0.146)	(0.185)
IMPCH*I(young)		-1.219***									
		(0.210)									
IMPCH*I(Old)			1.219***								
			(0.210)								
IMPCH*I(logTFP)				0.631***							
				(0.042)							
IMPCH*I(Capital-Labor Ratio)					-1.119***						
					(0.0415)						
IMPCH interacted by workers size											
IMPCH*I(Big top 20%)						4.452***					
						(1.019)					
IMPCH*I(Small)							-3.067***				
							(0.505)				
IMPCH interacted by Market Share											
IMPCH*I(High Market Share)								2.843***			
								(0.660)			
IMPCH*I(Low Market Share)									-2.657***		
									(0.536)		
IMPCH*I(Skilled Workers)										-6.004***	
										(0.249)	
IMPCH*I(Unskilled Workers)											6.005***
											(0.249)
Observations	84,485	84,485	84,485	83,611	73,747	84,485	30,163	84,485	30,159	84,208	84,208
Number of firm_ID	12,057	12,057	12,057	11,988	10,889	12,057	6,161	12,057	6,160	12,030	12,030
Cragg-Donald Wald F statistic	1273.3***	57.8***	57.8***	89.4***	91.7***	298***	265.6***	234.8***	64.9***	57.2**	65.9***

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. All models included Firm Fixed Effects and by State-Year fixed effects.For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 5: *The Impact of Chinese Import Competition on Average Wages*

	Dependent variable: Log Average Wage										
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
IMPCH	-0.165***	-0.142**	-0.302***	-3.359***	-0.720***	-0.221***	0.207	-0.259***	0.424***	-0.957***	1.082***
	(0.053)	(0.066)	(0.095)	(0.141)	(0.065)	(0.059)	(0.149)	(0.062)	(0.158)	(0.078)	(0.098)
IMPCH*I(Young)		-0.159									
		(0.111)									
IMPCH*I(Old)			0.159								
			(0.111)								
IMPCH*I(logTFP)				0.658***							
				(0.027)							
IMPCH*I(Capital-Labor Ratio)					0.459***						
					(0.023)						
IMPCH interacted by workers size											
IMPCH*I(Big top 20%)						1.390***					
						(0.419)					
IMPCH*I(Small)							-0.670***				
							(0.258)				
IMPCH interacted by Market Share											
IMPCH*I(High Market Share)								0.999***			
								(0.283)			
IMPCH*I(Low Market Share)									-1.171***		
									(0.284)		
IMPCH*I(Skilled Workers)										2.039***	
										(0.131)	
IMPCH*I(Unskilled Workers)											-2.039***
											(0.131)
Firm Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
By year-state fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	78,675	78,675	78,675	73,733	77,926	78,675	25,951	78,675	25,947	74,329	74,329
Number of firm_ID	10,982	10,982	10,982	10,889	10,924	10,982	5,366	10,982	5,365	10,936	10,936
Cragg-Donald Wald F statistic	2347***	245***	278.1***	65.9***	99.8***	562.9***	587.2***	355.3**	371.7***	92.4***	105.6***

Robust standard errors in parentheses,clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. All models included Firm Fixed Effects and by State-Year fixed effects. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 6: *The Impact of Chinese Import Competition on Plant Productivity*

	Dependent Variable: Log TFP							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMPCH	-0.264**	-0.125	-0.831***	0.016	-0.361***	-0.121	-0.479***	0.066
	(0.115)	(0.138)	(0.229)	(0.131)	(0.127)	(0.331)	(0.133)	(0.308)
IMPCH*I(young)		-0.706***						
		(0.259)						
IMPCH*I(Old)			0.706***					
			(0.259)					
IMPCH*I(Capital-Labor Ratio)				-0.242***				
				(0.028)				
IMPCH interacted by workers size								
IMPCH*I(Big top 20%)					2.379**			
					(1.064)			
IMPCH*I(Small)						-0.064		
						(0.498)		
IMPCH interacted by Market Share								
IMPCH*I(High Market Share)							2.298***	
							(0.595)	
IMPCH*I(Low Market Share)								-0.524
								(0.551)
Firm Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
By year-state fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	83,917	83,611	83,611	73,746	83,611	29,794	83,611	29,790
Number of firm_ID	12,000	11,988	11,988	10,889	11,988	6,110	11,988	6,109
Cragg-Donald Wald F statistic	2164.2***	82.2***	74.9***	234.2***	213.9***	93.5***	125.8***	176.8***

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By state by year fixed effects are partial led out. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

Table 7: *The Impact of Chinese Import Competition on Plants Exit*

	Dependent Variable: Plant Exit							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMPCH	0.761***	-0.615***	2.358***	1.115***	0.132***	-0.003	0.224***	-0.126
	(0.222)	(0.036)	(0.141)	(0.079)	(0.035)	(0.143)	(0.042)	(0.138)
IMPCH*I(young)		2.973***						
		(0.149)						
IMPCH*I(Old)			-2.973***					
			(0.149)					
IMPCH*I(lTFP)				-0.217***				
				(0.015)				
IMPCH interacted by workers size								
IMPCH*I(Big top 20%)					-2.064***			
					(0.465)			
IMPCH*I(Small)						-0.007		
						(0.283)		
IMPCH interacted by Market Share								
IMPCH*I(High Market Share top 20%)							-1.859***	
							(0.315)	
IMPCH*I(Low Market Share)								0.289
								(0.325)
Firm Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓
By year-state fixed effects	✓	✓	✓	✓	✓	✓	✓	✓
Observations	83,174	66,711	66,711	66,130	58,642	66,711	22,789	66,711
Number of firm_ID	11,248	10,930	10,930	10,853	9,790	10,930	5,411	10,930

The dependent exit variable, is a dummy variable that takes 1 if plant i exits the market at period $t+1$. The coefficients are obtained using a probit model with instrumental variable. Robust standard errors in parentheses. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By state by year fixed effects are partial led out.

Table 8: *The Impact of Chinese Competition on Entry to Manufacturing Industry*

Dependent Variable: Total 4 digit ISIC Industry Entrants			
	(1)	(2)	(3)
IMPCH	-0.603***	-0.681***	-0.674***
	(0.099)	(0.094)	(0.062)
IMP		-0.727***	-0.719***
		(0.051)	(0.040)
Real Wage			-0.305**
			(0.147)
Real Exchange Rate			0.216***
			(0.014)
Industry Fixed Effects	✓	✓	✓
Year Fixed Effects	✓	✓	✓
Observations	1,318	1,318	1,318

Robust standard errors in parentheses, clustered by 4 digit ISIC industries.

***, ** and * indicate significance at 1%, 5% and 10% levels respectively.

Table 9: *The Impact of Chinese Import Competition on Skill Intensity*

	Dependent Variable: log Skill intensity								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
IMPCH	-0.086	-0.056	-0.188	-0.021	-0.059	-0.612**	0.484**	-0.071	-0.393
	(0.455)	(0.134)	(0.178)	(0.122)	(0.117)	(0.286)	(0.222)	(0.123)	(0.250)
IMPCH*I(young)		-0.132							
		(0.211)							
IMPCH*I(Old)			0.132						
			(0.211)						
IMPCH*I(Capital-Labor Ratio)				0.083***					
				(0.024)					
IMPCH interacted by workers size									
IMPCH*I(Big top 20%)					-0.884				
					(0.657)				
IMPCH*I(Small)						0.365			
						(0.451)			
IMPCH*I(TFP)							0.117***		
							(0.039)		
IMPCH interacted by Market Share									
IMPCH*I(High Market Share)								-0.174	
								(0.451)	
IMPCH*I(Low Market Share)									-0.102
									(0.423)
Firm Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
By year-state fixed effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	80,180	80,180	80,180	70,573	80,180	27,746	79,475	80,180	27,742
Number of firm_ID	11,583	11,583	11,583	10,510	11,583	5,801	11,529	11,583	5,800
Cragg-Donald Wald F statistic	2368.9***	86.9***	112.5***	273.6***	215.1**	234.6***	129.8***	142.7***	156.3***

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By state by year fixed effects are partial led out. For the Wald Statistic: *** = p < .05 less than 10% IV bias, ** = p < .05 less than 15% IV bias, *= p < .05 less than 20% IV bias

A. Appendix

i. Data

Firm-level Data

In order to study the impact of Chinese import competition on Colombian plants performance, we match the trade data with the Colombian Annual Manufacturing Survey (AMS). The (AMS), is an unbalanced panel that registers information on all manufacturing establishments with 10 or more employees. The goal of AMS is to obtain basic information from the industrial sector, which would provide facts about its structure, characteristics and evolution. The AMS provides the annual information about the behavior, changes and evolution of the manufacturing industry in Colombia. This information is obtained through a number of establishments, employed personnel, accrued remunerations (wages, salaries and social contributions), gross and industrial output, intermediate consumption, value added, gross and net investment, electricity consumed, fixed assets values, amongst others. The (AMS) is conducted by the Colombian Bureau of Statistics (Departamento Administrativo Nacional de Estadistica or DANE). For the purpose of this study, we have data covering the 2000-2012 period, at an annual frequency. Even though the data on firms is available until the 2016, the reason to carry out the analysis of this paper until 2012, is to avoid potential contamination in the import competition rate caused by the entrance in force of the free trade agreement between Colombia and U.S.

Trade Data

The trade data used to compute the import competition measure were taken from the UNCOMTRADE database, initially the trade data was downloaded as six-digit Harmonized System (HS) which is product-level data and then was converted into its ISIC rev.3 version, which is 4 digit disaggregated industry-level data, by using the official correspondence table from HS96 to ISIC rev.3 available at the United Nations website. We proceed in this way, because UNCOMTRADE database is the only source of disaggregate trade data for Colombia, specifically was the only way to get four-digit disaggregated trade industry level data.

ii. Additional Robustness Checks

Given that the main aim of this paper is to identify the casual effect of Chinese import competition on the performance of manufacturing firms in a developing economy as Colombia, this objective of obtain such unbiased estimation is jeopardize by the potential endogenity problem involved in our analysis. As we argue in the methodological section, is reasonable to think that the Chinese Import competition measure is correlated to unobservable technology and demand shocks. Moreover, such correlation may be stronger for products where both China's and Colombia's comparative advantages are high, hence it might soften the competition effect.

As robustness check this paper also considers an additional instrumental variable (IV) strategy based on China joining the WTO and the initial conditions. Since we are interested in capturing accelerating Chinese imports following from the WTO accession, the instruments should capture this 'China' driven component unrelated to the Colombian imports demand factors. Moreover, since sectors in which China was already exporting in 1999 such as textiles, furniture and toys are likely to be those where China had a comparative advantage and are also the sectors which experienced much more rapid increase in import penetration in the subsequent years. Consequently, high exposure to Chinese imports prior to the China accession to the WTO as for instance in 1999 can be used as a potential instrument for subsequent Chinese import growth. Moreover, this measure is interacted with the exogenous overall growth of Chinese imports, calculated excluding the Colombian imports.

Therefore, the new instrument considered for the Chinese share of import penetration rate is the worldwide Chinese imports interacted with the 1999 Chinese import share in the corresponding 4 digit ISIC industry in Colombia. $IV_2 = (CH^x_{jt} - CHCOL^x_{jt}) * IMCH_{j99}$. By doing so, we get the cross-industry variation in the degree of Chinese import competition.

Table 10: *First Stage IV-2 Results*

Variables	(1) CH Import Competition	(2) CH Import Competition
$IV_2 = IMCH_{j99} * (CH^x_{jt} - CHCOL^x_{jt})$	0.075***	0.072***
	(0.004)	(0.011)
Year Fixed Effects	✓	
Firm and Industry Controls		✓
Firm Fixed Effects	✓	✓
Kleibergen-Paap LM statistic (p-value)	635.2 (0.00)	589.5 (0.00)
Cragg-Donald Wald F statistic	467.8***	365.1***

Robust standard errors in parentheses, clustered by each industry and year.

*** p<0.01, ** p<0.05, * p<0.1. Firms controls are: Age dummies and multiplant. Industry control: Import penetration No-China

To be a good instrument this new variable must meet the exogenity and relevance conditions. We argue that, the worldwide Chinese imports must be exogenous from the perspective of Colombian manufacturing plants as it is driven just by China. Furthermore the instrument is intuitively relevant given the correlation of China's export expansion in industries where it has already a comparative advantage, as is suggested by Amiti and Freund (2008)[15].

Table 10, show the first stage results of the new instrument, all the coefficients are significant, all show a strong correlation between the independent variable the Chinese import competition rate and the new instrument. Moreover, regarding to the relevance and validity of instruments, the underidentification test, Kleibergen-Paap LM statistic, rejected the null hypothesis, indicating that the matrix is full column rank and the model is identified and the Cragg-Donald Wald F statistic, in both models is larger indicating that $IV_2 = IMCH_{j99} * (CH^x_{jt} - CHCOL^x_{jt})$ is a good instrument for the Chinese import penetration rate.

Moreover, the results in table 11, allows to argue that the main results of this paper are robust to the several instruments used to solve the intrinsic endogenity problem of Chinese import competition measure. Columns 1 and 2, as in the main regression, suggest a negative impact of increasing Chinese import competition on the gross and industrial outputs for an average manufacturing plant in Colombia. On the other hand, the coefficient in column 7, estimating the effect of Chinese import competition on sales , confirm the previous insights about the no evidence of Chinese

[15]They argued that three quarters of the aggregate growth of Chinese imports was from the expansion of existing products rather than from adding new products.

competition affecting manufacturing sales. Putting together these two results regarding outputs and sales, this paper suggest a possible change of profit strategy among plants, moving from producing to resell activities decreasing in turn its value added as is shown in column 6.

Regarding to employment, the results do not find evidence to suggest a negative affect of Chinese competition for an average plant. Furthermore, skill upgrading is not a response of an average manufacturing plant in Colombia to increasing Chinese competition. Finally, the finding of a negative effect of Chinese import competition on a average plant's productivity is robust to considering a different instrument.

Table 11: *Robustness Check: Results with Alternative Instrument*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variables	Log Gr.Output	Log In.Output	Log Avg. Wage	Total Workforce	Direct Workers	Log Val. Added	Log Sales	log TFP	Skill Intensity
IMPCH No Controls	-0.546***	-0.542***	-0.199***	-0.088	-0.098	-0.574***	-0.251	-0.280**	-0.091
	(0.160)	(0.160)	(0.0649)	(0.117)	(0.152)	(0.188)	(0.163)	(0.132)	(0.125)
IMPCH Idustry	-0.512***	-0.507***	-0.173***	-0.074	-0.097	-0.546***	-0.263	-0.292**	-0.087
	(0.147)	(0.147)	(0.057)	(0.108)	(0.136)	(0.173)	(0.148)	(0.122)	(0.115)
IMPCH Firms controls	-0.545***	-0.542***	-0.200***	-0.089	-0.102	-0.576***	-0.267	-0.279**	-0.090
	(0.160)	(0.160)	(0.065)	(0.117)	(0.152)	(0.188)	(0.163)	(0.132)	(0.125)
Plant Fixed Effects	✓	✓		✓	✓	✓		✓	✓
Year by State Fixed Effects	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of Plant ID	12,099	12,098	10,982	12,057	10,982	12,099	12,009	11,988	11,583
Observations	89,465	89,461	78,675	84,485	78,688	89,463	88,274	83,611	80,180

Robust standard errors in parentheses, clustered by each industry and year. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By state by year fixed effects are partial led out. Firms controls are: Age dummies and multi plant. Industry control: Import penetration No-China

iii. Additional Descriptive Statistics, Variables Definition and Calculations

Table 12: *Distribution of Plants by 4 digit ISIC.Rev.3 Industries*

ISIC.Rev.3	Freq.	Percent	ISIC.Rev.3	Freq.	Percent	ISIC.Rev.3	Freq.	Percent	ISIC.Rev.3	Freq.	Percent
1511	2,081	2.01	1926	542	0.52	2430	37	0.04	2926	80	0.08
1512	168	0.16	1929	124	0.12	2511	74	0.07	2927	2	0.00
1521	666	0.64	1931	531	0.51	2512	185	0.18	2929	1,280	1.23
1522	660	0.64	1932	122	0.12	2513	57	0.05	2930	281	0.27
1530	1,681	1.62	1939	75	0.07	2519	647	0.62	3000	9	0.01
1541	1,649	1.59	2010	612	0.59	2521	1,491	1.44	3110	427	0.41
1542	150	0.14	2020	186	0.18	2529	4,452	4.29	3120	415	0.40
1543	740	0.71	2030	286	0.28	2610	757	0.73	3130	36	0.03
1551	6,109	5.89	2040	233	0.22	2691	82	0.08	3140	68	0.07
1552	241	0.23	2090	466	0.45	2692	123	0.12	3150	425	0.41
1561	681	0.66	2101	424	0.41	2693	1,211	1.17	3190	330	0.32
1562	23	0.02	2102	1,184	1.14	2694	285	0.27	3210	112	0.11
1563	293	0.28	2109	1,324	1.28	2695	1,425	1.37	3220	2	0.00
1564	238	0.23	2211	753	0.73	2696	339	0.33	3230	48	0.05
1571	137	0.13	2212	414	0.40	2699	975	0.94	3311	1,117	1.08
1572	122	0.12	2213	50	0.05	2710	1,302	1.26	3312	234	0.23
1581	693	0.67	2219	421	0.41	2721	58	0.06	3313	2	0.00
1589	2,834	2.73	2220	3,231	3.12	2729	426	0.41	3320	88	0.08
1591	269	0.26	2231	164	0.16	2731	64	0.06	3330	1	0.00
1592	195	0.19	2232	180	0.17	2732	145	0.14	3410	130	0.13
1593	25	0.02	2233	452	0.44	2811	2,197	2.12	3420	742	0.72
1594	870	0.84	2234	80	0.08	2812	153	0.15	3430	1,134	1.09
1600	30	0.03	2239	1	0.00	2813	88	0.08	3511	2	0.00
1710	192	0.19	2240	1	0.00	2891	3	0.00	3512	38	0.04
1720	497	0.48	2310	25	0.02	2892	625	0.60	3520	1	0.00
1730	1,137	1.10	2321	45	0.04	2893	512	0.49	3530	63	0.06
1741	803	0.77	2322	313	0.30	2899	2,823	2.72	3591	156	0.15
1742	119	0.11	2323	50	0.05	2911	1	0.00	3592	71	0.07
1743	137	0.13	2330	209	0.20	2912	399	0.38	3599	207	0.20
1749	716	0.69	2411	984	0.95	2913	192	0.19	3611	1,669	1.61
1750	1,168	1.13	2412	361	0.35	2914	130	0.13	3612	1,364	1.32
1810	10,254	9.89	2413	278	0.27	2915	204	0.20	3613	568	0.55
1820	52	0.05	2414	27	0.03	2919	1,599	1.54	3614	686	0.66
1910	453	0.44	2421	334	0.32	2921	374	0.36	3619	467	0.45
1921	1,701	1.64	2422	742	0.72	2922	329	0.32	3691	135	0.13
1922	133	0.13	2423	1,914	1.85	2923	2	0.00	3693	768	0.74
1923	3	0.00	2424	1,840	1.77	2924	181	0.17	3694	221	0.21
1924	214	0.21	2429	1,158	1.12	2925	371	0.36	3699	7,425	7.16
1925	291	0.28							Total	103,683	100.00

Note: Author own calculations. Each plant was matched to its unique industry category, classified following the International Standard Industrial Classification, ISIC Rev.3. Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM), conducted by the Colombian Bureau of Statistics, Departamento Administrativo Nacional de Estadistica, DANE.

Table 13: *Distribution of Plants by Two Digit ISIC Industries*

Industry	ISIC 2 digit Code	Number of Plants	Percent
Manufacture of food and beverage	15	20,525	19.80
Manufacture of tobacco products	16	30	0.03
Manufacture of textiles	17	4,769	4.60
Manufacture of wearing apparel	18	10,306	9.94
Tanning and dressing of leather	19	4,189	4.04
Manufacture of wood and of products	20	1,783	1.72
Manufacture of paper and paper products	21	2,932	2.83
Publishing, printing and reproduction	22	5,747	5.54
Manufacture of coke, refined petroleum	23	642	0.62
Manufacture of chemicals	24	7,675	7.40
Manufacture of rubber and plastics	25	6,906	6.66
Manufacture of other non-metallic minerals	26	5,197	5.01
Manufacture of basic metals	27	1,995	1.92
Manufacture of fabricated metal prod.	28	6,401	6.17
Manufacture of machinery and equipment	29	5,425	5.23
Manufacture of office and computing	30	9	0.01
Manufacture of electrical machinery	31	1,701	1.64
Manufacture of radio, television	32	162	0.16
Manufacture of medical instruments	33	1,442	1.39
Manufacture of motor vehicles	34	2,006	1.93
Manufacture of other transport equipment	35	538	0.52
Furniture and Others	36	13,303	12.83
Total		103,683	100.00

Note: Author own calculations. Each plant was matched to its unique industry category, classified following the International Standard Industrial Classification, ISIC Rev.3. Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM), conducted by the Colombian Bureau of Statistics, Departamento Administrativo Nacional de Estadistica, DANE.

Table 14: *Evolution of Chinese Import Penetration Rate for each 2 Digit Industries*

Industry	2 Digit Code	2000	2002	2004	2006	2008	2010	2012
Manufacture of food products and bevera	15	.00004	.00048	.00140	.02446	.01791	.02892	.04255
Manufacture of tobacco products	16	.	.	.	.	3.51e-06	.	.
Manufacture of textiles	17	.00779	.01667	.03026	.02996	.07368	.11349	.26803
Manufacture of wearing apparel	18	.00139	.02858	.04381	.06454	.09632	.12678	.29905
Tanning and dressing of leather; manufa	19	.00009	.02858	.04381	.06454	.09632	.12678	.00399
Manufacture of wood and of products of	20	.00026	.00110	.00198	.01109	.01711	.01268	.01312
Manufacture of paper and paper products	21	.00018	.00062	.00333	.00225	.00444	.00503	.00875
Publishing, printing and reproduction o	22	.00130	.00288	.00832	.00579	.00647	.01163	.01815
Manufacture of coke, refined petroleum	23	0	.00304	.01032	.00654	.00569	0	0
Manufacture of chemicals and chemical p	24	.00433	.00768	.01573	.02075	.04414	.03841	.06145
Manufacture of rubber and plastics prod	25	.02855	.02040	.04267	.07973	.08922	.13838	.17824
Manufacture of other non-metallic miner	26	.00304	.00370	.02204	.06220	.08568	.09779	.12706
Manufacture of basic metals	27	.00189	.00312	.00726	.04127	.17265	.13120	.19890
Manufacture of fabricated metal product	28	.00836	.01461	.04251	.05496	.09190	.08983	.13536
Manufacture of machinery and equipment	29	.00942	.02035	.08222	.10304	.21550	.26073	.35509
Manufacture of office and computing mac	30	.07647	.	.	.	.	.	.
Manufacture of electrical machinery and	31	.03965	.08706	.12779	.17350	.24537	.27314	.38037
Manufacture of radio, television and co	32	.09125	.11437	.31162	.36033	.33135	.26233	.22179
Manufacture of medical and optical inst	33	.00748	.02974	.07561	.12179	.13004	.17428	.22055
Manufacture of motor vehicles	34	.00148	.00389	.01403	.05828	.07582	.07884	.
Manufacture of other transport equipment	35	.02716	.06521	.05233	.26422	.17995	.18530	.06345
Furniture and Others	36	.11268	.13742	.18339	.23728	.31049	.32573	.69474

Note: Author own calculations. The values correspond to the simple industry average of Chinese Import Penetration Rate, calculated as in section V equation 1. Each plant was matched to its unique industry category, classified following the International Standard Industrial Classification, ISIC Rev.3. Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM) and trade data comes from UNCONTRADE.

iii.1 Import Competition Measures for Colombian Industries

Chinese Import Penetration Rate

A measure of Chinese import competition for Colombian firms was built as the Chinese share of the import penetration for the matched industry, following Bernard, Jensen and Schott (2006):

$$IMPCH_{jt} = \frac{M_{jt}^{ch}}{M_{j00} + Q_{j00} - X_{j00}} \tag{6}$$

Where, M_{jt}^{ch} denotes the value of imports of industry j coming from China to Colombia at period t. M, Q and X denote total Colombian imports, production and exports, respectively at the initial year 2000.

Import Competition Rate Excluding China

Another measure of import competition for Colombian firms was built, as following:

$$IMPNCH_{jt} = \frac{M_{jt}^{w} - M_{jt}^{ch}}{M_{j00} + Q_{j00} - X_{j00}} \tag{7}$$

Where, the numerator denotes the value of total Colombian imports of industry j at period t, excluding those coming from China, for the respective industry. M, Q and X denote total Colombian imports, production and exports, respectively at the initial year 2000.

Total Import Competition Rate

Finally, we also might use the following total import competition measure:

$$IMPW_{jt} = \frac{M_{jt}^{w}}{M_{j00} + Q_{j00} - X_{j00}} \tag{8}$$

Where, M_{jt}^{w} denotes the value of total imports of industry j at period t. M, Q and X denote total Colombian imports, production and exports, respectively at the initial year 2000.

Colombia's Top Trading Partners and Exporting Markets

According to the OCDE, Colombia is the 55th largest export economy in the world. In 2016, Colombia exported $32.9B and imported $43.2B, resulting in a negative trade balance of $10.3B. In 2016 the GDP of Colombia was $282B and its GDP per capita was $14.2k.

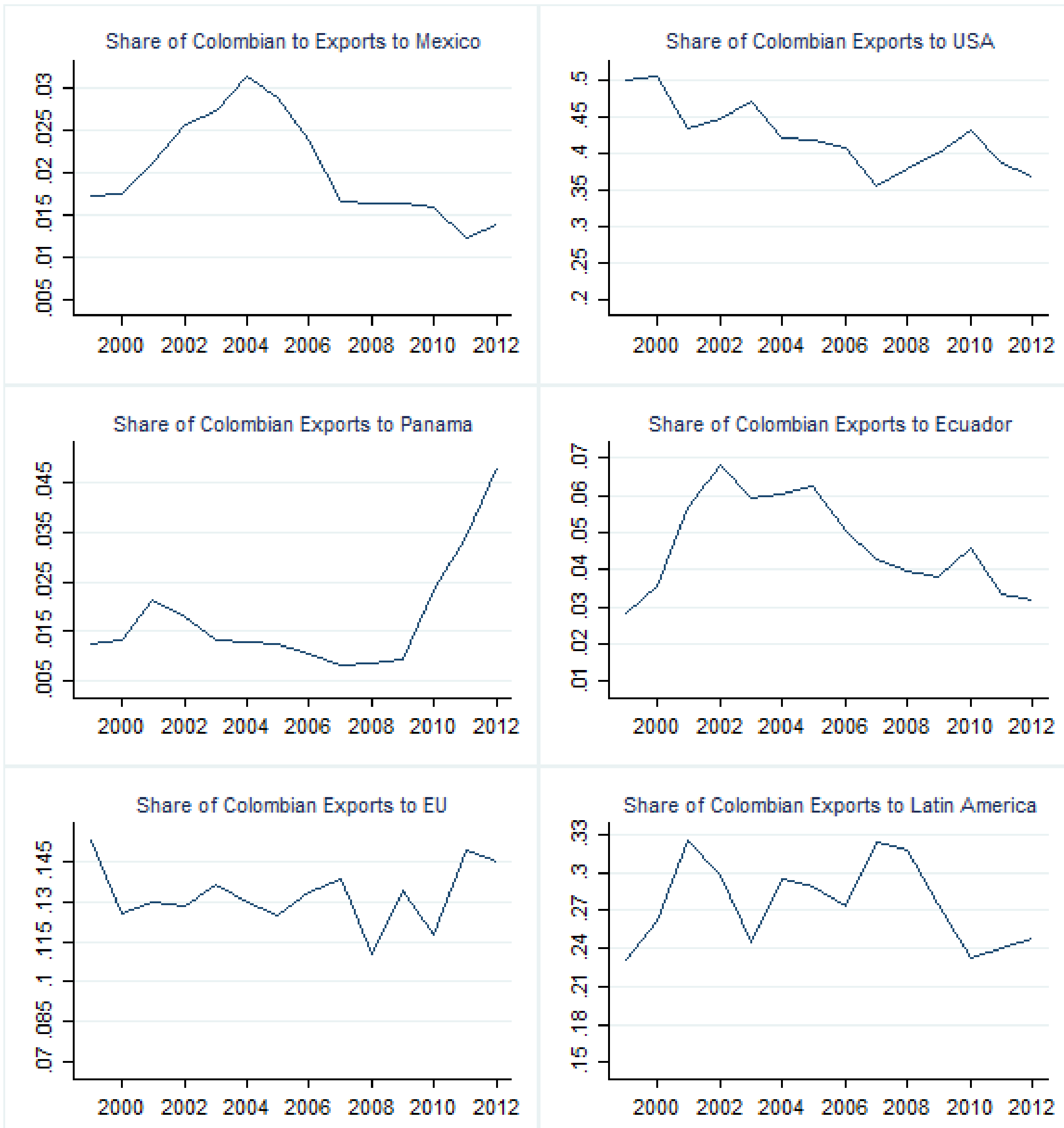
The top exports of Colombia are Crude Petroleum (25%), Coal Briquettes (16.5%), Coffee (7.8%), Refined Petroleum (5.9%) and Gold (4.2%), using the 1992 revision of the HS (Harmonized System) classification. Its top imports are Refined Petroleum (7.6%), Cars (4.2%), Packaged Medicaments (2.89%), Broadcasting Equipment (2.8%) and Computers (2.56%).

The top export destinations of Colombia are the United States (31.9%), Panama (5.8%), the Netherlands (4.6%), Ecuador (3.7%) and Spain (3.6%). *The top import origins are the United States (26.8%), China (19.6%), Mexico (7.8%), Brazil (5%) and Germany (3.88%).*

Figure 4: *Evolution of Colombian top Importers*

Source: Author's own calculation. Data comes from UNCOMTRADE

Figure 5: *Evolution of Colombian top Exports Destination*



Source: Author's own calculation. Data comes from UNCOMTRADE. The European Union includes the followings Countries: Belgium, Denmark, France, Germany, Italy, Netherlands, Spain, Portugal and United Kingdom. Latin American countries: Argentina, Bolivia, Brazil, Cost Rica, Chile, Cuba, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

Table 15: *Trade Agreements of Colombia*

Multilateral Agreements		
Agreement-Partner(s)	Date of Signature	
WTO members	30 April 1995Âă	
Customs Unions		
Agreement-Partner(s)	Date of Signature	
Andean Community	26 May 1969	
Free Trade Agreements		
Agreement-Partner(s)	*Date of Signature*	*Date of Entry into Force*
Pacific Alliance	10 February 2014	01 May 2016
Costa Rica	05 May 2013	01 August 2016
Republic of Korea	21 February 2013	15 July 2016
European Union	26 June 2012	
European Free Trade Association (EFTA)	25 November 2008	01 July 2011
Canada	21 November 2008	15 August 2011
Northem Triangle (El Salvador, Guatemala and Honduras)	09 August 2007	
Chile	27 November 2006	08 May 2009
United States of America	22 November 2006	15 May 2012
Mexico	13 June 1994	
Preferential Trade Agreements		
Agreement-Partner(s)	*Date of Signature*	*Date of Entry into Force*
Venezuela (AAP.C N. 28)	28 November 2011	19 October 2012
Colombia - Ecuador - Venezuela - MERCOSUR (AAP.CE N. 59)	18 October 2004	
CARICOM (AAP.A25TM N.31)	24 July 1994	01 January 1995
Panama (AAP.AT25TM N. 29)	09 July 1993	18 January 1995
Nicaragua (AAP.AT25TM N. 6)	02 March 1984	
Costa Rica (AAP.A25TM N. 7)	02 March 1984	
Economic Association Agreements		
Agreement-Partner(s)	*Date of Signature*	
MERCOSUR AAP.CE N. 72	21 July 2017	
Free Trade Agreements signed but not in force		
Agreement-Partner(s) Âă	*Date of Signature*	
Israel	30 September 2013	
Panama	20 September 2013	

Table 16: *Plants Characteristics 2000-2012*

Variables	Obs.	Mean	SD	Min	Max
Energy (kwh)	82,537	1.645e+06	1.141e+07	0	5.301e+08
Gross Output	82,537	1.584e+07	9.343e+07	1,932	5.839e+09
Industrial Output	82,537	1.580e+07	9.344e+07	0	5.875e+09
Intermediate Consumption	82,537	9.202e+06	5.322e+07	0	3.765e+09
Wages	82,537	657,189	1.826e+06	0	5.083e+07
Gross Investment	82,537	608,580	7.911e+06	-1.110e+09	6.569e+08
Fixed Assets	82,537	9.841e+06	5.885e+07	0	3.308e+09
Total Workforce	96,806	76.92	149.3	0	2,949
Direct Workers	104,036	44.17	88.35	0	1,754
Value Added	82,537	6.635e+06	4.445e+07	36	2.537e+09
Input Value	75,307	8.595e+06	5.324e+07	0	3.650e+09
Sales	82,537	1.592e+07	9.253e+07	0	6.030e+09
Export	104,036	0.327	0.469	0	1

Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (AMS), conducted by the Colombian Bureau of Statistics, Departamento Administrativo Nacional de Estadistica, DANE. Monetary values are expressed in thousand COP and deflated using its corresponding price index.

Plant Entry and Exit within the Annual Manufacturing Survey 2000-2012

In order to identify the plants that exit or entry from our dataset, during the 2000-2012 period, we proceed as follows.

First, we balanced the dataset, using the fillin command, in order to Rectangularize the panel data set, running the command: `fillin firm_ID year`. Giving that, _fillin is 1 for observations created by using fillin and 0 for previously existing observations. we can defined an operate variable as:

```
bys firm_ID: gen operate=1 if _fillin==0
bys firm_ID: replace operate=0 if _fillin==1
```

Then we defined, as Entry and Exit, respectively:

```
bys firm_ID: gen entry=0
bys firm_ID: replace entry=1 if operate[_n-1]==0 & operate[_n]==1 & year!=2000
bys firm_ID: gen exit=0
```

```
bys firm_ID: replace exit=1 if operate[_n]==1 & operate[_n+1]==0
```

Table 17: *Percentage of Plants that Entered and Exited. AMS 2000-2012*

Exit and Entrants		
Year	% of Entrants	% Exited
2000	0	4.01
2001	1.95	3.49
2002	2.93	2.87
2003	5.36	3.01
2004	3.14	2.35
2005	4.31	3.10
2006	2.00	3.24
2007	2.47	2.92
2008	7.73	3.36
2009	11.88	3.67
2010	9.46	3.67
2011	2.70	4.06
2012	1.40	0

Estimating Production Function for Plants at AMS 2000-2012

Before estimating production function for plants at AMS 2000-2012, we deflected nominal values using its corresponding available deflector. In that sense, the variables: `gross_output ind_output value_added sales`, were deflected by the manufacturing sector PPI. In the case of the variables: `gross_investment fixed_assets` were deflected using the capital goods PPI. Moreover, the variables `val_inputs interm_consump` were deflected using the intermediate consumption PPI. Finally, for the `wages` variable we used the CPI deflector.

We estimate the following Cobb Douglas production function for plant i at time t:

$$y_{it} = \alpha + w_{it}\beta + k_{it}\gamma + \omega_{it} + \epsilon_{it} \tag{9}$$

where y_{it} is the log value added , w it is a $1 * J$ vector of log free variables (labor) and k it is a $1 * K$ vector of log state variables (capital). The random component ω it is the unobservable productivity or technical efficiency and ϵ it is an idiosyncratic output shock distributed as white noise. According to Olley and Pakes, we assume that productivity evolves according to a first-order Markov process.

Stata Estimation

We implemented an slightly different version of the Olley and Pakes approach to estimate a Cobb Douglas production function with the Stata command `prodest`, using the method O.P. but instead of use the investments as proxy, we used the intermediate consumption variable, which accounts for the total intermediate materials employed by the firms to produce their goods. Moreover, in some specifications we control for firm exit and whether the firm exports. The baseline command is showed below.

```
prodest lvalue_added_df, free(ltot_workforce) state(lactivfi_df)
proxy(linterm_consump_df) va met(op) reps(40) id(firm_ID) t(year) attrition
```

Table 18: *Production Function Estimation Results*

	(1)	(2)	(3)	(4)
Variables	lvalue_added	lvalue_added	lvalue_added	lvalue_added
ltot_workforce	0.500***		0.486***	
	(0.011)		(0.010)	
lworkers		0.053***		0.052***
		(0.007)		(0.006)
lfixed_assets	0.387***	0.388***	0.370***	0.388***
	(0.010)	(0.007)	(0.009)	(0.009)
export			✓	✓
exit	✓	✓	✓	✓
Observations	66,043	74,440	66,043	74,440
Number of groups	12,892	13,812	12,892	13,812

Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1

Estimating Productivity (TFP) for Plants at AMS 2000-2012

We now use our production function estimates to construct the plant specific productivity level, which can be calculated as:

$$tfp_{it} = exp(y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it}) \tag{10}$$

Where the parameter estimates $\hat{\beta}_l$ and $\hat{\beta}_k$, are taken from columm (3) in table 18. Moreover, an aggregated 4 digit ISIC manufacturing industry productivity, was calculated annually as the mean weighted average of each plant belonging to such industry, using plant output share over total industry output as weights. Proceeding in the same way, we calculated the mean weighted average for each two digit ISIC manufacturing industry. The below graphs shows the productivity evolution of some selected two digit industries.

Table 19: *Average 2 Digit Industry TFP in 2000 and 2012*

		2000			2012		
Industry	**2 Digit Code**	Obs	Mean	Std.	Obs	Mean	Std.
Manufacture of food products and beverage	15	1,631	4.953	.9046	1,796	4.927	.9738
Manufacture of tobacco products	16	3	5.383	0	0		
Manufacture of textiles	17	351	4.862	.9094	801	4.730	.8030
Manufacture of wearing apparel	18	58	5.192	.8546	976	4.971	.9520
Tanning and dressing of leather	19	293	4.793	.7562	309	4.657	.9142
Manufacture of wood and of products of	20	100	4.549	.8629	189	4.729	.8262
Manufacture of paper and paper products	21	151	4.968	.7286	578	4.794	.7944
Publishing, printing and reproduction o	22	428	4.882	.9680	206	5.352	1.056
Manufacture of coke, refined petroleum	23	5	6.050	.7542	252	5.536	1.067
Manufacture of chemicals and chemical p	24	379	5.322	.9294	461	5.321	.9188
Manufacture of rubber and plastics prod	25	97	4.735	.8089	200	4.731	.8006
Manufacture of other non-metallic miner	26	288	4.668	.8607	517	4.847	.9674
Manufacture of basic metals	27	248	4.836	.8471	164	4.937	1.019
Manufacture of fabricated metal product	28	316	4.759	.7296	394	4.835	.8855
Manufacture of machinery and equipment	29	424	4.782	.7778	412	4.847	.9137
Manufacture of office and computing mac	30	3	4.945	.478	0		
Manufacture of electrical machinery and	31	19	5.002	.6051	153	4.965	.9638
Manufacture of radio, television and co	32	17	4.849	.8395	0		
Manufacture of medical and optical inst	33	288	4.780	.7740	575	4.968	1.073
Manufacture of motor vehicles	34	27	4.717	.8540	183	4.881	.8538
Manufacture of other transport equipment	35	21	5.139	.5018	76	4.969	1.033
Furniture and Others	36	1,984	4.896	.9180	916	4.699	.916

Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM). Specify plant productivity calculated according to equation (10). The variable reported here for the years 2000 and 2012, correspond to the log transformation of TFP.

Table 20: *Two Digit Industries across States of Colombia*

State/Industry	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Antioquia	11.90		9.02	19.27	3.44	1.97	2.59	4.58	0.25	7.23	7.83	6.06	1.78	6.77	4.77		2.00	0.19	1.00	1.54	0.59	7.20
Atlantico	22.72		2.36	8.25	0.99	2.51	1.88	4.20	1.73	9.51	6.92	5.55	1.98	5.68	6.33				1.14	1.46	1.35	15.44
Bogota	12.52		5.11	8.97	4.81	1.62	2.58	9.74	0.53	9.63	9.17	2.63	1.65	7.74	6.89	0.07	2.67	0.23	1.09	3.06	0.51	8.77
Bolivar	21.14			0.37		4.17		2.67	0.44	15.67	9.14	7.15	5.53	5.97	0.37				0.06		2.24	25.06
Boyaca	15.37			2.16		1.14		2.54		1.52		17.92	14.89	3.81	1.52				0.13	3.30		35.71
Caldas	27.54		0.95	3.99	1.77	3.40		4.48		3.13	2.26	7.56	3.03	15.58	4.76		1.81	0.05	0.05	0.23	0.27	19.16
Cauca	28.37						7.07	3.72		2.68	9.68	9.01	1.12	5.66	0.30		3.05		0.07			29.26
Cesar	68.28											9.20										22.52
Cordoba	63.17					4.03		0.27											0.27			32.26
Cundinamarca	22.94		1.63	0.81	0.86	1.96	0.98	0.29	0.86	15.61	8.50	13.18	3.12	6.56	4.24		0.43		0.02	3.48		14.55
Huila	48.55									5.80		13.62								0.43		31.59
Magdalena	62.09							0.15		0.45	1.79	7.46							0.45			27.61
Meta	68.79									0.15		6.36	0.91		2.12				0.15			21.52
Narino	64.65							0.81						0.13								34.41
Norte de Santander	34.18			7.42	17.01	0.58		2.01			3.44	14.84		4.93	0.58							15
Quindio	23.33			10.62	12.96			1.36			1.11	5.06		7.65								37.90
Risaralda	18.84		1.10	21.11	2.76	0.12	1.79	3.57		0.73	5.20	5.56	0.04	3.41	3.82		2.44		0.12	2.35	2.19	24.85
Santander	29.89	0.55	0.53	13.95	11.42	2.51	0.76	2.70	0.74	2.35	4.49	4.68	1.27	4.02	5.15				0.02	1.94		13.03
Sucre	33.52											20.33							0.55			45.60
Tolima	49.35		0.13	16.24	0.13	0.39		0.84	0.45	0.26	0.97	2.85		2.13	1.94							24.32
Valle del Cauca	24.57		1.75	9.98	3.79	1.70	5.31	5.23	0.26	8.28	8.45	3.62	2.01	6.04	6.13		1.59	0.31	0.24	1.43	0.34	8.96
Casanare	60.44																					39.56
Vichada	53.77					2.83																43.40

Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM). This table shows the representativity of each industry on the horizontal axis, in each State of Colombia. For instance in the Vichada State, the 55.77% of plants in our dataset belongs to the 2 digit ISIC Industry code 15 -Manufacture of food and beverage. Whereas, the 2.83% of plants in the state of Vichada in our dataset perform its industrial activity in the industry code 20 -Manufacture of wood and products of wood.

Table 21: *Frequency Distribution of the Data across all States in Colombia*

State	Total Obs	Share %
Antioquia	20,680	19.89
Atlantico	4,740	4.56
Bogota	37,578	36.14
Bolivar	1,608	1.55
Boyaca	787	0.76
Caldas	2208	2.12
Cauca	1,343	1.29
Cesar	413	0.40
Cordoba	372	0.36
Cundinamarca	4,908	4.72
Huila	690	0.66
Magdalena	670	0.64
Meta	660	0.63
Narino	744	0.72
Norte de Santander	1,887	1.81
Quindio	810	0.78
Risaralda	2463	2.37
Santander	4,895	4.71
Sucre	182	0.18
Tolima	1,546	1.49
Valle del Cauca	14,496	13.94
Casanare	91	0.09
Vichada	212	0.20
Total	103,983	100

Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (AMS), conducted by the Colombian Bureau of Statistics, Departamento Administrativo Nacional de Estadistica, DANE.

Table 22: *Local Labor Markets in States of Colombia in 2000*

State	Total Employment	Number of firms	Firm Av. Size
Antioquia	128305	273	84.97
Atlantico	35827	101	90.24
Bogota	157201	402	69.58
Bolivar	11610	29	87.29
Boyaca	5766	8	115.32
Caldas	13423	32	69.54
Cauca	6813	13	72.47
Cesar	2769	4	89.32
Cordoba	2227	5	71.83
Cundinamarca	31498	42	111.30
Huila	1821	7	36.42
Magdalena	2084	14	39.32
Meta	3245	6	67.60
Narino	2553	16	43.27
Norte de Santander	4962	40	28.51
Quindio	1920	16	25.26
Risaralda	15652	42	74.53
Santander	640	78	38.10
Sucre	7575	4	40
Tolima	80418	34	50.83
Valle del Cauca	81865	215	80.74
Casanare	482	10	82.60
Vichada	303	7	14.42

Author's own calculation. Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM).

Table 23: *Employment, Firm size and number of Firms across Industries in 2000*

Two digit Industry	Industry Code	Total Employment	Num. firms	Firm Av. Size
Manufacture of food products and beverage	15	122701	288	78.50
Manufacture of tobacco products	16	60	3	20
Manufacture of textiles	17	42450	66	133.91
Manufacture of wearing apparel	18	67853	126	86.65
Tanning and dressing of leather; manufacture	19	15266	89	46.26
Manufacture of wood and of products of	20	4108	15	39.5
Manufacture of paper and paper products	21	18486	40	77.34
Publishing, printing and reproduction o	22	20923	70	60.82
Manufacture of coke, refined petroleum	23	2000	8	74.07
Manufacture of chemicals and chemical p	24	48718	74	100.65
Manufacture of rubber and plastics prod	25	32812	64	71.33
Manufacture of other non-metallic miner	26	25615	61	70.56
Manufacture of basic metals	27	11484	29	90.42
Manufacture of fabricated metal product	28	20216	70	50.03
Manufacture of machinery and equipment	29	18143	78	51.54
Manufacture of office and computing mac	30	29	1	29
Manufacture of electrical machinery and	31	8175	19	62.88
Manufacture of radio, television and co	32	1853	3	115.81
Manufacture of medical and optical inst	33	2519	24	42.69
Manufacture of motor vehicles	34	8425	17	65.82
Manufacture of other transport equipment	35	3436	8	88.10
Furniture and Others	36	59134	291	60.40

Data on plants comes from the Colombian Annual Manufacturing Survey or Encuesta Anual Manufacturera (EAM) and trade data comes from UNCONTRADE.

Chapter 3.

Does Import Competition Discourages Innovation Efforts of Manufacturing Firms? Evidence for a Developing Economy.

Victor Zapata*

Abstract

This paper examines the effect of intensified Chinese import competition on the innovation inputs and outputs of a developing economy, using a novel and rich data for Colombian manufacturing firms. Finding that, on average heightened Chinese import competition triggers a negative effect on the innovation inputs and outputs of manufacturing firms. Considering several dimensions of heterogenity across firms, we find that, while initially less productive and less profitable firms significantly reduced in greater extent their R&D spending, training investments, and the number of workers devoted to R&D activities. More productive firms are more likely to innovate in response to Chinese import competition, specially by increasing the registers of intellectual property rights. Moreover, for relative bigger firms the training and R&D investments are more negative affected by Chinese import competition. Whereas, for initially smaller firms, the production of intellectual property rights is more negative affected when facing increasing Chinese import competition. These results are robust after addressing the simultaneity bias between imports demand or technology shocks and innovation activities as well as after controlling for the within industries differences in innovation patterns.

JEL Classification: *F14 F6, O3, O54*

Keywords: *Innovation Output, R&D Investment, Intellectual Property Right, Import Penetration Rate, Trade Policy, Innovation Input, R&D activities.*

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I. Introduction

The accession of China to the WTO in 2001, represents one of the most important phenomenon in international trade. Just ten year later, by 2011 China overtook Germany to become the world's largest manufacturing exporter, having increased its share in world exports to almost 16% up from around 3% in 1999, exerting a tremendous competitive pressures on the rest of world economies. (Hanson, 2012).

Substantial evidence now suggests that an exposure to Chinese import competition may have adverse effects on several dimensions of manufacturing firms in developed countries, including the survival rate of manufacturing plants (Bernard et al., 2006), large contraction in manufacturing employment (Acemoglu et al., 2016; Pierce and Schott, 2016), depressing wages and the employment prospects for occupations and skills which can be substituted from Chinese goods (David et al., 2013; Ebenstein et al., 2014; Utar, 2014; Autor et al., 2016). Similarly, there is an other stream of literature that studies the effect of Chinese import competition on the performance of manufacturing firms in developing economics. However, this growing literature, have mainly focused on the effect of increasing Chinese import competition for Mexican maquiladoras competing in the U.S market. For instance, Utar and Ruiz (2013) argued that Competition from China has negative and significant impact on employment and plant growth, both through the intensive and the extensive margin, on the most unskilled labor intensive sectors, leading to sectoral reallocation. Furthermore, Iacovone et al. (2013), Chinese import penetration reduces sales of smaller Mexican plants and more marginal products and they are more likely to cease. Moreover, in the case of Colombian firms, the only reference on the implications of international competition on manufacturing firm performance, has been presented by Zapata (2018) finding that competition from China has negative impact on employment, sales and value added. Additionally, encourages plant exit and discourages entry, whereas, skill upgrading only occurs in more productive and more capital-intensive plants.

However, the impact of import competition from China on innovation has far comparably received less attention. Just until very recent years this topic began to be considered. The awareness of the importance of analyzing the effect of import competition on innovation is crucial, since manufacturing still generates the majority of R&D spending and innovation, the relationship between international competition and the creation of new or improvement of products and production processes, is thus one of most important strategies to cope with international import competition for the rest of economies. In this regard, have emerged a debated derived from mixed evidence on the effects of Chinese import competition on innovation of two prominent papers. Collecting data for a large sample of European firms, Bloom et al. (2016) find that innovating firms have actively responded to the intensified Chinese import competition by increasing a wider range of innovative activities including patenting, research and development expenditures, computer usage, and TFP growth. The contradictory evidence is presented in the study of Dorn et al. (2016) arguing that Chinese import competition does actually lead to not only a decline in patenting by U.S. firms but also the profitability and R&D investment in the affected industries.

Contrary to the existing works on import competition and innovation, the aim of this paper, is to investigate the impact of import competition from China on the innovation inputs and outputs of Manufacturing firm in developing economies, specifically using firm-level data for manufacturing firms in Colombia. We construct a rich database that gather information for each single firm about, trade at performing industry level, innovation indicators at firm specific level and firms characteristics. As identification strategy, this study exploits the exogenous intensification of Chinese import competition and the fact that not all firms in its determined industry are not exposed to import competition in the same degree, this setting yields an unparalleled opportunity to examine the innovative behavior of firms under the threat of import competition. Moreover, using a valid instrumental approach, we are able to present results that allow us to inference a causal effect of competition from China on manufacturing firms' innovation indicators.

Additional to the previous mentioned two papers, this study is closely related to an emerging literature on the impacts of import competition on innovation related outcomes for manufacturing firms. Gutiérrez and Philippon (2017) argued that industry leaders invest and innovate more in response to exogenous changes in Chinese competition. Moreover, Xu and Gong (2017) find that import competition induces R&D expenditures to be reallocated towards more productive and more profitable firms within each industry. Such reallocation effect has the potential to offset the average drop in firm-level R&D. Lastly, Kueng et al. (2016) find that firms in industries more affected by Chinese import competition experience a strong decline in innovation outcomes, especially in process innovations.

The contribution of this paper to the stream of literature analyzing the effect of Chinese import competition on innovation, is threefold: first, this study extended the analysis on the effect of import competition on innovation by considering a broad dimension of innovation indicators that accounts for both inputs and outputs such specialized training investment, workers engaged in R&D activities, and intellectual property rights different to patenting that are also, outcomes of innovation efforts carried out by the firms. The broad definition of property rights include the development of new Softwares, Industrial Designs, Copyrights, Patent and Utility Models. Moreover, by consider these broad category of innovation outputs, we are able to have a more comprehensive measure of innovations that is intuitively more accurate for the case of manufacturing firms in developing economies as Colombia. In addition to analyze the effect of Chinese competition on innovation inputs and outputs, this paper –in contrast to the existing literature– also considers particular innovation inputs as the training investment and the number of workers engaged in the R&D sector within firm, as main complementary strategies to R&D investments that are fundamental for the innovation process.

Second, in order to identify the impact of heightened Chinese import competition on innovation of manufacturing firms in Colombia[1], the identification strategy rely on an instrumental variable approach to deal with the endogenity problem that arises, due to factors such as demand or technology shocks for particular products or industries in the domestic market can be correlated with the firm innovation indicators. In that sense this

[1]One potential advantage of using data for Colombian manufacturing firms is derived from the fact that final tariff rates were exogenously predetermined (Attanasio et al., 2004) and the country was fully integrated to the world economy when the China accession to the WTO took place in December 2001.

study is able to identify the causal effect of Chinese import competition on innovation indicators of manufacturings firms.

Third, this paper represent the first attempt to understand the effect of increasing Chinese import competition on the innovation efforts in developing economies approximated by the results obtained using data on Colombian firms, in that sense it contributes to fill the gap in the literature about this topic by analyzing the impact of intensified Chinese competition on innovation inputs and outputs of manufacturing firms performing in a different environment other than to the high income economies case. Although, the R&D spending as a share of GDP is quiet low among this category of countries, is pretty interesting to analyze whether and in which magnitude the competition from China may discourage moderate innovation inputs and outputs among developing countries, where financial depth, the protection of intellectual property rights, the government capacity to mobilize resources and the quality of research institutions are weaknesses that potentially may become innovative firms more vulnerable to trade-shocks as the China-shock.

This study finds that excepting for the case of R&D workers, the average effect of Chinese import competition on the innovation inputs and outputs of Colombian manufacturing is negative and statistically significant. Suggesting that increasing import competition form China is discouraging innovation efforts of manufacturing firms in Colombia. However, these on average results conceal very heterogeneous responses for different types of firms with diverse initial characteristics. In this respect, the innovation indicators of initially less productive and less profitable firms, are more negative affected by Chinese imports competition, firms in these groups significantly reduced in greater extent their R&D and training investments, as well as the number of workers devoted to R&D activities. In terms of size, the results suggest that among relative bigger firms innovations inputs such as, specialized training and R&D investments are more negative affected by Chinese import competition. However, regarding to production of intellectual property rights are the initially smaller firms more negative affected when facing increasing Chinese import competition.

Furthermore, regarding to firms with different productivity level, we find that, while Chinese import competition specially affects innovation inputs among initially less productive firms rather than innovation outputs, since these types of firms in presence of import competition reduce their R&D investment, cut the number of workers in R&D activities and scaled back the specialized training investment. More productive firms innovate more in response to the China trade shock, specially by increasing the broad categories of intellectual property rights (when considering not only patents).

The results presented in this paper complement the findings of the previous study about the effect of Chinese import competition on Colombian manufacturing firms. It allows to argue that greater Chinese import competition for manufacturing firms triggers a more general decline in their profitability, thereby reducing incentives to innovate and invest in R&D. The contraction along all margins of firm's innovation suggest that the primary response of firms to greater import competition from China is to cut back their innovation related investments.

The paper continues as follows: In the next section presents the economic theory about the relationship between competition and the innovation process. Section II, presents the theoretical consideration to address the impact of Chinese competition on innovation. Section III, contain a detail description of the data used in this paper and it explains how the dataset was built. Additionally, it also present a review on the innovation dynamics of manufacturing firms in Colombia. Section IV, introduces the methodological approach and the identification strategy. Finally sections V, present the results analysis, followed by concluding remarks and discussion in section VI.

II. Economic Theory of Competition and Innovation

The incentive to innovate is the difference in profit that a firm can earn if it invests in R&D compared to what it would earn if it did not invest. These incentives depend upon many factors including: the characteristics of the invention, the strength of intellectual property protection, the extent of competition before and after innovation, barriers to entry in production, R&D investments and the dynamics of R&D sector. The incentive to innovate clearly depends on the nature of rights to successful innovation. If an innovator can not exclude imitators or prevent independent discovery of similar ideas, this reduces the benefit from innovating, holding constant any spillover effects from others' innovation efforts. Economic theory does not offer a prediction about the effects of competition on innovation that is robust to all of these different market and technological conditions. Therefore, the study of how import competition and innovation and how these relationship may differ across countries, competitive structures and firms heterogeneity is relevant in actual understanding of the "gains" of trade.

The pioneer paper of Schumpeter (1942) claim that high competition can decrease innovation by significantly reducing a firm's post-innovation rents. In standard oligopoly models, a more competitive product market tends to generate lower investment in innovative activity (Dasgupta and Stiglitz, 1980). The underlying mechanism is straightforward: more competition means lower profits and reduced incentives to invest. The competition-innovation relationship becomes more complex once allowing for firm heterogeneity. According to Aghion et al. (2005) the relationship between competition and innovation follows an inverted U shape. Innovation is relatively low when firms are either too dissimilar, such that laggards are unable to overtake leaders, or at the opposite extreme where competition is close to perfect competition, there is almost no room for rent capture. At intermediate levels of competition, post-innovation rents may exceed rents pre-innovation, resulting in relatively high levels of investment in R&D in these market segments.

Bloom et al. (2013) introduced a theoretical model of international competition and innovation. They argued that, before to the China-shock, there are "trapped" factors of production protected by trade barriers, employed by firms in developed economies in the production of old goods. When import barriers are lowered, China starts exporting and the profitability of making old goods falls. Causing in turn, a decrease of the opportunity cost of the trapped factors, meaning that the cost of producing new goods with these production factors also falls and therefore the combination of both mechanism result in reducing the costs of innovation and increases the profitability of innovation. An similar mechanism operates in Bloom et al. (2014), who consider incumbent firms facing an exogenous increase in import penetration. If moving costs temporarily "trap" some productive factors inside firms, then an increase in product-market competition lowers the cost of using these factors from production to innovation. Consequently, greater import competition may lead to accelerated productivity growth.

On the other hand, in a different modeling framework, Thoenig and Verdier (2003) postulates that firms in developed countries innovate more by upgrading their technologies when they are more exposed to low-cost import competitions. Moreover, high competition can decrease innovation by lowering firm's internal resources for innovation (Hall and Lerner, 2010), by encourage a competitive entrant to innovate without displacing its own profits (Arrow, 1972), and by enabling a firm to become a technological leader via innovation and thus escape from competition (Aghion et al., 2001).

Given these mixed predictions of the impact of competition on firm innovation resulting in the absence of a clear theoretical guidance, the effects of Chinese import competition is an intrinsically empirical question, specially in the case of developing economies.

III. Data

The dataset was built by first matching the industry level trade data to Colombian manufacturing industries in order to create measures of Chinese import penetration. The second step was, to match this industry trade data with The Development and Technological Innovation Industrial Survey of Colombian manufacturing firms, using the firms industry affiliation, in order to obtain detailed information on innovation and technological change activities conducted by manufacturing firms in Colombia. Jointly, the resulting data allows to analyze the impact of industry-level Chinese import competition shock on firm-level innovation related activities and indicators.

i. Trade Data

The trade data used to compute the import competition measure was taken from the *UN-COMTRADE* database, initially the trade data was downloaded as six-digit Harmonized System (HS) which is product-level data and then was converted into its ISIC rev.3 version, which is 4 digit disaggregated industry-level data, by using the official correspondence table from HS96 to ISIC rev.3 available at the United Nations website.[2]

A measure of Chinese import competition for Colombian firms was built as the Chinese share of the import penetration for the matched industry, following Bernard et al. (2006):

$$IMPCH_{jt} = \frac{M_{jt}^{ch}}{M_{j04} + Q_{j04} - X_{j04}} \tag{1}$$

Where, M_{jt}^{ch} denotes the value of imports of industry j coming from China to Colombia at period t. M, Q and X denote total Colombian imports, production and exports, respectively at the initial year 2004.

Import penetration rate indicate to what degree domestic demand is satisfied by imports from China. As the previous study of Zapata (2018), analyzing the effect of Chinese competition on the performance of manufacturing firms in Colombia. Domestic demand supplied by imports from China exhibited a dynamic increase since 2003, scaling up to almost dominated as a source of imports in the traditional labor-intensive sectors such as clothing, footwear and other manufactures. By 2012 China extended its penetration to relative high-technology sectors as electronic and machinery, where Chinese imports accounts almost for the 40% of the Colombian demand for products within this industries.

ii. Firm-level data and Innovation indicators

The data about innovation inputs and outputs comes from the Survey of Development and Technological Innovation for Colombian Manufacturing Firms. *EDITH*. The aim of *EDITH* is to establish a statistical framework to identify the technical features and dynamics of the technological development of Colombian manufacturing firms. By reporting variables that directly and indirectly affect the creation of new products, processes, marketing techniques and forms of organization, or their substantial improvement, as well as, its impact on the economy. The innovation survey for the manufacturing industry is carried out every two years and includes detailed information on innovation outputs and inputs, types of innovation, objectives when investing and developing innovations, investment on

[2]We proceed in this way, because UNCOMTRADE database is the only source of disaggregate trade data for Colombia, specifically was the only way to get four-digit disaggregated trade industry level data.

innovation activities, sources of ideas, obstacles to innovation, financial sources, access to public funding, relations to other actors of the innovation system and intellectual property.

The survey began to be carried out consistently by the Colombian Bureau of Statistics *Departamento Administrativo Nacional de Estadistica, DANE* in 2005, taking 2003 and 2004 as reference period. During 2009, the DANE carried out an improvement in the data capturing instrument, through the redesign of the collection questionnaire, in accordance with the standards found in the international manuals on measurement of Science, Technology and Health indicators. The result is a significantly improved form, oriented to guarantee, a decrease in the attrition of the source during the filling process, and on the other hand, an increase in the quality of the data.

In order to obtain very detailed firm-level database that gathers information on innovation and technological activities developed by manufacturing firms in Colombia, as well as the main characteristics of these firms within its specific industry, we matched the *EDITH* to Colombian Annual Manufacturing Survey or *Encuesta Anual Manufacturera, EAM*, which is an unbalanced panel that registers information on all manufacturing establishments with 10 or more employees, recording information on output value, number of employees, value of inputs used, total investment, value of the stock of capital, value of domestic and export sales and purchases of capital. These firms are located in 27 of 32 states in Colombia.

Given that each firm belongs to a just one industry category, classified according to the economic activity that they carry out following the *International Standard Industrial Classification, ISIC Rev.3*.[3] We are able to match each firm with the corresponding industry Chinese import penetration rate data.

The resulting dataset contains 37.582 observation, for 8.549 firms performing their economy activity in one of the 115 different 4 digit manufacturing industries. Table 1 shows the distribution of these firms among 22 two digit manufacturing sectors, giving a representative picture of the manufacturing sector in Colombia, which is very typical for

[3]DANE Colombia has modified the original ISIC Rev.3 into a Colombian version, therefore in order to match properly each plant with the imports data of its corresponding industry, we first fixed the ISIC Rev.3 with the ISIC Rev.3 adjusted for Colombia, by following the correspondence table at DANE website.

developing economies. The majority of firms are performing in: manufacture food and beverage, manufacture wearing apparel, manufacture rubber and plastic products, and furniture and others. Such manufacturing industries can be classified as labor-intensive and relative low technology industries. This representative structure of the manufacturing sector in Colombia, not only is very similar to other Latin American and developing economies, but also it strongly differs to the developed economy case, where the manufacturing sector is oriented to more high-technology and skilled-intensive industries as the manufacture of machinery and equipment, Manufacture of office and computing machinery, Manufacture of electrical machinery and apparatus and Manufacture of motor vehicles.

iii. Innovation efforts across Manufacturing firms in Colombia

In Colombia, according to the Colombian Observatory for Science and Technology, *OCYT*, the combination of both, national investments in scientific, technological and innovation Activities and the expenditure in R&D, have increased from 0.59% to 0.86% as a percentage of the GDP, between 2004 and 2012. It should be highlighted that, while in 2004, the private sector financed 61.2% of all the science and technology activities in the country and the public sector financed 37.8%. By 2013, the proportion shifted, being the public sector the greater financing sector of innovation activities in Colombia accounting for the 51% of total spending in innovation activities. Regarding to the specific case of firms, it important to notice that the share of expenditure in science and technology activities financed by firms, has decreased from 41% in 2004 to 31.2% in 2013 (Lucio et al., 2014).

Traditionally, manufacturing firms are far more likely than non-manufacturing firms to introduce new products and new production or business processes, in all manufacturing industries, including such reputedly "low technology" ones. Although all manufacturing industries surpass the non-manufacturing averages innovation indicators, some are more likely than others to be product or process innovators. It is well known that among the most innovative manufacturing industries worldwide, measured by either product or process introductions, are several computer and communications industries and the pharmaceutical industry. Chemicals and the majority of durable goods industries, including motor vehicles, aerospace, and machinery, also equaled or exceeded the averages for all of manufacturing. The typical manufacturing industries in which both product and process introductions are less than the manufacturing averages are wood products, nonmetallic mineral products, furniture, primary metals, food, and textiles and apparel. In order to identify the causal effect of Chinese import competition on innovation process, is very important to adequately account for these sectoral differences.

In order to investigate the effect of increasing Chinese import competition on innovation efforts of manufacturing firms in Colombia, we examine the followings indicators of innovation and technological change: holding a patent, R&D investment, total number of intellectual property rights, total number of workers devoted to R&D activities and investment in specialized training. All the innovation inputs (R&D and training investments, workers devoted to R&D) are directly reported by the firms and taken from *EDITH*. On the other hand, innovation outputs were calculated as follows: Holding a patent is a dummy variable, that takes value of 1 if the firm hold at last one patent register and 0 otherwise. Whereas, intellectual property rights variable, accounts for the number of intellectual property rights that a firm holds regardless of its nature, these rights can be in the form of Software right, Industrial Designs, Copyright, Patent and Utility Model. However, in this category trademark rights are excluded.

Table 2 shows the descriptive statistics about the innovation inputs and outputs in our sample. It is noted that the 2.2 percentage of all surveyed firms in 2004 hold a patent register. The leaders industries on innovation in Colombia manufacturing sector are: Manufacture of chemicals and chemical products (6%), Publishing, printing and reproduction of recorded media (3.9%), Manufacture of medical and optical instruments, watches (4.8%) and Manufacture of other transport equipment (3%). Since the percentage of firms within these sectors holding a patent register is above manufacturing average in 2004. Moreover, firms in industries such as: Manufacture of chemicals and chemical products, Manufacture of tobacco products, Manufacture of electrical machinery and apparatus and Manufacture of rubber and plastics products; are the most active ones in R&D investment. Additionally, the industries where the average number of workers engage in R&D is larger are: Manufacture of tobacco products, Manufacture of chemicals and chemical products and Manufacture of electrical machinery and apparatus.

Furthermore, figures 2, 3 and 4 plots the average 4 digit industry innovation indicators –R&D workers, training Investment and R&D investment, respectively– against the Chinese import penetration rate in a specific year. All graphs shown that as the Chinese import penetration rate increases, firms performing in most affected industries exhibit consistently low innovation indicators. Additionally, the raw correlation between Chinese import competition and innovation efforts and outcomes is negative for Colombian manufacturing firms. Moreover graph 5, show that the predicted probability of holding a patent is decreasing across industries facing more Chinese import competition.

IV. Methodological Approach

To investigate the effect of increasing Chinese import competition on innovation efforts of manufacturing firms in Colombia, the baseline regression specification is:

$$lnY_{ijt} = \beta_0 + \beta_1 IMPCH_{jt} + \beta_2 X_{ijt} + \beta_3 Ind_{jt} + d_t + c_i + \epsilon_{ijt} \tag{2}$$

where, lnY_{ijt} refers to the firm indicators of innovation and technological change (holding a patent, R&D investment, among others) at firm i in industry j at year t. $IMPCH_{jt}$ is the Chinese import competition measure for industry j at time t as defined in equation (1). Vector X includes relevant time varying firm-level controls, these are basically multi-plant, exporter, importer and age proxy.[4] Vector Ind_{jt} accounts time varying industry-wide controls, in general these are industry aggregate variables for the matched industries that may affect the demand for a particular manufacturing sector, specifically we included here, the world import penetration rate of the corresponding Colombian industry calculated without the imports from China. d_t are year fixed effects added to control for aggregate shocks that may affect the variable of interest across all sectors. Given the panel aspect of the data we consider c_i as the unobserved heterogeneity. The standard errors are clustered by each industry in each year to account for correlation of shocks within each industry-year.

[4]Since EAM does not report the year when the plant was established, we calculated an age variable according to the number of years that firms have been in the sample since 2000 to have a notion of firm's age.

We exploit both the sectoral variation and the variation across time in the slope in the evolution of the average Chinese import competition rate for High and low threat industries, as well as the Overall manufacturing sector average in Colombia (as is shown in figure 1) to identify the Chinese competition effect on Innovations indicators of Colombian Manufacturing firms. [5]

There are several concerns about estimating equation (2) in OLS and interpreting the coefficient on $\beta 1$ as causal. First, observed changes in the import penetration ratio may in part reflect domestic shocks to Colombian industries that determine both import demand and innovative activity. Even if the dominant factors driving China's export growth are internal supply shocks, the import demand shocks may still affecting bilateral trade flows. This type of endogeneity bias might work against finding any impact of Chinese competition, because both Colombian and Chinese imports are expected to react to these types of unobservable shocks in the same direction, hence it might cancel the competition effect. Therefore, is reasonable to think that ϵ_{ijst} is correlated with $IMPCH_{jt}$, leading to $E[IMPCH, \epsilon] \neq 0$. The correlation between the independent variables with unobserved factors would bias our results. While we do not have a strong prior on the direction of bias in OLS estimates, because for instance, in the case that domestic firms' profits rise with greater demand, they allocate more resources for innovation activities, but it might also be the case that, a rise in demand may signaling reducing needs for innovation. Therefore, we rely on the IV approach because the source of variation is well understood.

To address this problem, we use Chinese world export supplies or the worldwide imports from China, as an instrument that is correlated with Colombian imports from

[5]The low threat Chinese competition industries in Colombia are mainly: food products and beverages. Manufacture of builders' carpentry and joinery, sawmilling and planing of wood. Manufacture of pulp, paper and paperboard and corrugated paper, paperboard and of containers of paper. Manufacture of structural metal products, tanks, reservoirs and containers of metal, and steam generators. Manufacture of motor vehicles. Manufacture of other transport equipment. Whereas as high threat industries are Apparel, Footwear, luggage, handbags and the like saddlery and harness. Manufacture of machine-tools, machinery for textile, apparel and leather production. Manufacture of domestic appliances and Manufacture of electricity distribution, electric lamps and lighting equipment. Manufacture of musical instruments, of sports goods, games and toys. The sectors that do not belong to any of these groups can then be said to be intermediately exposed to Chinese competition (Zapata, 2018).

China but uncorrelated with the firms outcomes. The instrument IV_{jt} takes the form:

$$IV_{jt} = (CH^x_{jt} - CHCOL^x_{jt}) \tag{3}$$

Accounting for the China's total supply of products in industry j to the entire world -The worldwide Chinese imports-, minus the Chinese exports to Colombia -Chinese imports of Colombia- in period t.

To be valid our instrument must satisfy two requirements: first, the instrument must be uncorrelated with the error term, $Cov[z, u] = 0$, in other words the instrument must be exogenous. The worldwide Chinese imports must be exogenous from the perspective of Colombia firms as it is expected to be driven by rest of the world and China itself. Second the instrumental variable must be relevant, it must explain our endogenous variable, in our application this requires that our measure of Chinese import competition will partially correlated with the worldwide Chinese imports. Therefore, the instrument should capture the supply side driven growth component of Chinese imports independent from the Colombia demand factors, given that the causal relationship between the instrument and import penetration measure arises from the correlation between Colombia's imports for product of industry j and China's comparative advantage in that industry.

Formally, if the excludability and relevance conditions are met, then the instrumental variable estimator is a consistent estimator and it will indicate that neither endogeneity nor unobserved variable are driving our results and we will able to identify the causal effect of Chinese import competition on the Colombian manufacturing firms innovation activities.

Another empirical concern is the presence of industry pre-trends in innovation indicators. Figures mentioned above offers suggestive evidence as why it is crucial, to control for trends in the major innovation active industries as chemicals and electrical machinery and apparatus . Furthermore, characteristics such as industry factors intensity, and propensity to invest in information technology could all drive systematic differences across firms and industries in the potential for successful innovation. We account for these potentially factors by including an extensive set of controls consisting of dummy variables for the 11 manufacturing sectors shown in Table 2, and controls for industry factors at the initial period.

V. Results

In this section, the effects of Chinese import competition on the innovation of manufacturing firms in Colombia are presented and analyzed. In addition to standard model in the equation (2), we consider some extensions that explore who the effect of Chinese import competition on the innovation indicators of Colombian manufacturing firms might vary for different types of firm base on their initial conditions. Specifically, to investigate whether the impact of import competition on firm innovation is particularly negative for firms that were smaller, low skilled intensive, less productive and less profitable prior to the Chinese import competition surge.

For the purpose of such heterogeneity analysis we considered, first: different plant size groups High and Low measured by total workers and total sales. In order to define these groups we proceed as following: we considered the workers and the sales distribution of firms for the initial year 2004, then we calculated the quantiles for each distribution in that year. Defining the categories High, for those firms at fifth quantile, of the workers distribution and small, for those firms at the first and second quantile of the same total workers distribution. Likewise, in the case of sales, we defined a High group for firms at the top 20% of the sales distribution in the initial year and a Low group for those firms at the first and second quantiles.

Similarly, given the richness of our dataset we calculated a proxy for the profitability of each firm at the initial year, as the ratio of total sales over total workers, additionally we consider the separation of firms based on their initial skill intensity and productivity. The skill intensity measured as the share of skilled workers over total workers. In the other hand, the productivity of each firm was estimated following the Olley and Pakes approach adapting the variant recommended by Levinsohn and Petrin, 2003. The heterogeneity analysis include interactions between the Chinese import penetration rate and two subgroups dummies (High and Low) for each of these measures, that were identified and constructed according to quintiles distribution of the respective variable at the initial year. Therefore, the firm *i* belongs to the High group, if is located at the fifth quintile of the respective (skill intensity or profitability) distribution. Subsequently, the firm *i*, belongs to the low group if is located at the first and second quintile of the determined distribution.

i. Specialized Training

Table 3 contains the estimation results for the specialized training investment. The dependent variable is the logarithm of firm investment in specialized training. In column 3, the coefficient of the Chinese share of import penetration rate is negative and statistically significant at 1 percent level, indicating that for an average manufacturing firm, one standard deviation increase in the Chinese share of import penetration rate (11 percentage point increase) is associated with a 25 percentage point decrease in log specialized training investment. The instrumental variable results are presented in columns 4-6. The instrument for the Chinese share is the worldwide Chinese imports. The instrument is strongly correlated with IMPCH as reported at the first stage panel. Moreover, the weak identification test provide by the Cragg-Donald Wald F statistic, in both models was larger enough to suggest that the instrument performs well. The results indicate that the Chinese worldwide imports is a good instrument for the Chinese import penetration rate in Colombia. Furthermore, the IV coefficients are larger in magnitude suggesting that unobservable shocks bias the OLS coefficients downward.

In Table 4 the Chinese competition measure is interacted with firm's skill intensity, size and profitability at the initial year prior to the intensive expansion of the Chinese imports shock. The total number of firms in the sample was divided in two categories high and low. The results indicate that intensified Chinese import competition measure by the Chinese import penetration rate in Colombia causes a disproportionate decrease in training investment, especially in firms with higher initial training investments, as the group of big size firms, high-skill intensive firms and low profitable firms within an industry.

Specifically, we find that for big size firms measure by both sales and workers, the estimated coefficients in column 1-4 indicates that one standard deviation increase in the Chinese import penetration rate, reduces between 37 and 45 percentage points the specialized training investment among initially big size firms, while producing a 13 percentage points decrease for initially smaller firms. The negative effect of Chinese import competition on training investment is also larger among relative more skilled intensive firms compared to their low skilled intensive counterparts, where among the latter ones, one standard deviation increase in the Chinese import competition measure, produces a 15 percentage points decrease in the training investment, in contrast to 26 percentage points reduction in the high skilled intensive group.

On the other hand, the negative effect of heightened Chinese import competition on specialized training investment accrues more among low profitable firms relate to the high profitable ones. Specifically, one standard deviation increase in the Chinese import penetration rate, reduces the training investment by 37 and 16 percentage points, respectively.

ii. R&D Investment

One of the main questions in the study of firm innovation behavior is whether international import competition pressure increases or decreases firms' incentives to invest in R&D. The answer to this question has important implications for business strategies and competition policies. Existing studies provide diverse and conflicting results, predicting that import competition can have either a negative or a positive effect on firms' incentives to invest in R&D. Scherer and Huh (1992). Moreover, recent studies analyzing argued that the effect of import competition on firm performance varies with firms' stock of R&D capital. Showing that firms that have accumulated a higher stock of R&D capital are significantly less affected by import competition. Hombert and Matray (2018)

The estimation results of the effect of Chinese import competition on R&D investment of Colombian manufacturing firms are presented in Table 5. We control for whether a firm is located or not in the capital and economy hub Bogota, a firms' age proxy (based on the number of periods that a firm has been surveyed). We also include two-digit industry

fixed effects which capture broader industry trends. The estimation methods are OLS and IV, with p-values based on robust and clustered 4-digit ISIC industries and standard errors reported in parentheses.

The coefficients of Chinese import penetration are found to be negative and significant in every specification. Indicating that heightened Chinese import competition discourages R&D expenditure of manufacturing firms. Specifically, the magnitude in column 3 indicates that a one standard deviation increase in the Chinese import penetration rate (11 percentage point increase) is associated with a decrease in firm R&D investment of 16.9 percentage points. These results suggest that as Chinese import competition gets tougher, manufacturing firms in Colombia reduce their R&D investments. Instrumental variable regression results presented in columns 4 to 6 confirm the finding that Chinese imports competition lead to lower R&D spending of manufacturing firms.

However, the estimated negative average effect veil the heterogeneity among firms within the same industry. Chinese import competition may have a differential impact on a firm R&D investment, and thus can lead to the reallocation of R&D resources across firms in the same industry. Therefore, we test the effect of Chinese competition on R&D across three dimensions: size (measured by both sales and workers), profitability and skill intensity. Using the baseline equation, we empirically estimate the differential effect of Chinese import competition on firms relative big and small firms, with higher and low profitability, and firms with relative higher and low skill intensity. As usual, controls for the same firm characteristics and fixed effects are included.

The estimation results are presented in Table 6. In terms of size, columns 2 and 4 the coefficients on the interaction term are statistically significant, suggesting that smaller firms were responded to import competition from China by increasing their R&D investment. However, these coefficients are not so large enough to reverse the negative average effect of Chinese competition on R&D investment. Putting together with the results in column 1 and 3, we suggest that R&D spending is more negative affected by import competition among relative bigger firms.

Furthermore, regarding to the profitability dimension, we find that the negative effect of Chinese import competition on R&D investment is larger for firms with relative smaller profit margins, where one standard deviation increase in the Chinese import penetration rate produces a 23 percentage points decrease in the R&D investment. Last, columns 7 and

8 in table 6 explore what happens when skill intensity levels are interacted with Chinese import competition. Specifically, the coefficient in Column 8 is significant and positive, meaning that firms that were relative less skilled-intensive at the initial period, increased the R&D investment in the presence of import competition, however such effect is not larger enough to overcome the negative average effect of Chinese import competition on firms R&D spending.

These results are similar to those found by Holmes and Stevens (2010) introducing a structural trade model, to explain why import competition affect large-scale firms more than the small-scale ones. They argued that, large firms are more associated with mass production of standardized products, whereas small firms generally engages in the craft production of specialty products.

iii. Workers devoted to R&D Activities

In this section we analyze the effect of Chinese import competition on the number of workers devoted to R&D activities. This variable is directly reported by the firm to the *EDITH* survey. Specifically, in this category are included researchers, technicians, interns and assistants involved in scientific, technological and innovation activities related to the development of new or existing products and process. External consultants are excluded.

Table 7 contains the estimation results of the impact of Chinese import competition proxy by the Chinese import penetration rate, on the number of workers in positions related to R&D activities. The columns 1-3, shows the OLS results, in all model specification we get negative and significant coefficient of import competition on these category of high skilled workers,the increasing of Chinese import penetration rate and the decreasing in the number of workers devoted to R&D. On the other hand the instrumental variable approach showed in columns 4-6, the coefficients increase but lose their significance, meaning that on average we do not find a causal effect of increasing Chinese import competition on the demand for workers involve in R&D activities.

Furthermore, in table 8, we present the heterogeneous effects of Chinese import competition on R&D workers, by different firm size, profitability and skill-intensity. The results from column 1 to column 4, suggest that initially small size firms reacted to threatened Chinese import competition by increasing the number of worker in the R&D department. Such increases were even larger to slightly overcome the average negative effect of Chinese competition on R&D employment. Specifically, these coefficients indicate that one standard deviation increase in the Chinese import penetration rate, increases the log of R&D workers by 1.3 and 0.3 percentage points among small firms in the initial period, measure by both sales and workforce, respectively. Furthermore, when we compare the results between initially high and low skilled-intensive firms, we find evidence to suggest that initially less skilled-intensive, slight increased (0.4 percentage points) the number of workers involve in R&D activities in response to heightened Chinese import competition. Contrary, the number of workers in R&D activities is specially reduced among relative less profitable firms, in response to increasing Chinese import competition. Where, one standard deviation increase in the Chinese import penetration rate, is associated with a 3.8 decline in the log of workers devoted to research and development.

iv. Probability of Holding a Patent

A probit model with instrumental variable is used to analyze the impact of Chinese competition on the holding a patent status of the firm. The patent variable, $x_i t$ is a dummy variable that takes 1 if firm i have a patent at time t. In these regressions aggregate shocks and industry specific factors are controlled for using the full set of industry fixed effects. The results, presented in Table 9, shows significant negative effect of Chinese competition on the probability of holding a patent of a manufacturing firm. The results highlight the importance of controlling for firm export behavior, size, relative age, import penetration from the rest of world mainly positive spillover effects from developed economies and the economic and scientific hub of in the country, in the firm's probability of holding a patent register. Specifically, exporting, older and bigger firms, that are located in the capital and are performing in industries with intuitively positive technology spillovers, are more likely to hold a patent register. Particularly Column 3, indicate that one standard deviation increase in the Chinese import penetration rate reduces by 5.5 percentage points the firm's probability of holding a patent register.

The IV results in columns 4-6, confirm a negative and significant causal effect of Chinese import competition on the probability of holding a patent for Colombian manufacturing firms. Moreover, the instrument is strongly correlated with IMPCH and the estimated coefficients of this relation obtained using the instrumental method, are larger in magnitude than those in the OLS model, suggesting that unobservable shocks bias the OLS coefficients downward. Our finding of a significant negative impact of Chinese import competition on average patenting probability is similar to U.S case presented by Dorn et al. (2016)

On the other hand, table 10 explores how the effect Chinese import competition is distributed across different types of firms. We first analyze whether Chinese competition has a disproportionate effect among different firm sizes. The results of Column 1, 3 and 7, suggest that Chinese import competition is indeed increasing the probability of having a patent register among larger firms and more skilled intensive firms, as a respond of rising competition. Concretely, bigger firms measured by both sales and workers and skilled-intensive firms, exhibit an increase in the probability of holding a patent, that overcomes the average negative effect represented by the Chinese import competition. The coefficients in these columns, indicate that one standard deviation increase in the Chinese import penetration rate, increases around 0.5 and 4.5 percentage points, the probability of having a patent register for bigger firms. Whereas, the same change in the Chinese import competition rate, generates a 1.5 percentage points increase in the probability of holding a patent register among initially relative more skilled-intensive firms. Diversely, originally less profitable firms are more negative affect in the probability of patenting, when facing heightened Chinese import competition.

According to so called "*deep pocket effect*" due to capital market imperfections, firms mostly rely on their internal resources to undertake costly and risky innovative activities that potentially might result in patenting or other sort of property rights registers. For instance, Brown et al. (2009) present direct evidence that U.S. firms relied heavily on cash reserves to smooth R&D spending during the 1982-2002 boom and bust in stock market returns. Large firms are more likely to have such deep pockets capacity to navigate the difficult times. This could be especially important when market competition is intense and firms suffer from declining sales and profits, while small firms in tough times tend to be liquidity constrained.

v. Others Property Rights

In this section we extent the innovation outputs to include not only patents but rather any other property rights that manufacturing firms might holds. Therefore here, we consider a broad definition of property rights related to the development of new Softwares, Industrial Designs, Copyrights, Patent and Utility Models that encompasses new developments by the manufacturing firms that are industrially applicable to the technical solution or improvement to a given product, process or technical problem. Moreover, by considering these broad category of innovation outputs, we are able to have a more comprehensive measure of innovations that by definitions is more accurate for the case of manufacturing firms in a developing economic as Colombia. In that sense, the advantage for this study in including these sort of intellectual property rights in contrasts to other studies analyzing just the patent register are the followings: First, in a utility model register, the invention which has mainly a novelty, but less or absents in inventive step can be protected. Second, the cost to obtain and maintain the utility model and the software right are cheaper. Third, contrary to patents the additional intellectual property rights that we are considering, does not require substantive examination procedure, as it does not require the inventive step. Lastly, by including Copyrights for manufacturing firms enables to account for specific types of original creations, since Copyrights protects sound recording, literary works (with no requirement for artistic merit) and computer programs, and may also confer similar rights to protect databases. For instance, An instruction leaflet inside the box of a electronic item will be a literary work, as well as any text that the firm creates to guide their production process. Moreover, A picture or figure of a new prototype will be an artistic work subject to Copyright. Finally, in this category we excluded the trademark registers since this sort of property right are mainly related to the demand size.

Table 11 explore the effect of Chinese import competition on the production of intellectual property rights as a whole by manufacturing firms in Colombia. All the coefficients are negative and statistically significant across the OLS and IV estimations, suggesting a negative effect of Chinese import competition on manufacturing firms' production of innovation outputs. As in the previous sections the magnitude of the coefficients obtained using IV method are larger related to the OLS case, signaling that unobservable shocks drive the bias downwards. According to the coefficient in column 3, we suggest that one standard deviation increase in the Chinese import penetration rate, decreases in 2 percentage points the number of intellectual property right that an average manufacturing firms holds.

Furthermore, in Table 12 we analyze whether the effect of Chinese import competition on the production innovation outputs that are register by the firms as intellectual property rights, is disproportionated among different type of firms regarding size, profitability and skill intensity. We find that initially less profitable and smaller firms are more negative affected in the number of intellectual property rights when facing increasing Chinese import competition. Specifically, one standard deviation increase in the Chinese import penetration rate, translates in a reduction of around 3 percentage points in the number of property rights registers among less profitable firms. Whereas the same increase in the Chinese competition measure, decreases 1 and 1.3 percentage points the total number of intellectual property rights among small size firms measured by both sales and workforce, respectively. Finally, we do not find evidence of a heterogeneous effect of Chinese import competition on firm intellectual property rights register regarding to different skill intensity levels.

vi. Heterogeneity by Productivity level

In addition to the initial size, profitability and skill intensity dimensions of heterogeneous firms in the manufacturing sector. This section analyze whether the effect of import competition on innovation is different for firms who have higher or lower initial TFP.[6] In this regard, we calculate the quintiles of the productivity distribution at the initial year and then we categorized each firm at sample into the respective quintile creating a indicator variable for each of them and subsequently interacted by the Chinese import

[6] We estimated the firms specific productivity by using the following Olley and Pakes method adjusted by the Levinsohn and Petrin (2003) advice.

penetration rate[7].

Melitz (2003) model predicts that more productive firms are better positioned to first, take advantage of opportunities created by international trade openness and second, to face competition from other firms. In response to lower trade barriers, they will be able to expand their operations both domestically and abroad. However, for their less productive domestic peers, greater international competition makes them relatively likely to shut down their operations and among those that remain in business to reduce their production and market share. A similar argue is stated in the model of Aghion et al. (2005), where greater competition discourage incentives to innovate in industries with technological gaps.

Table 13 shows the estimation results exploring the impact of Chinese import competition on innovation inputs and outputs by different productivity levels. The panels A and B correspond to the less productive firms, located at the first and second quintile of the productivity distribution. We find that for initially less productive firms the innovation process measure through the innovations inputs and outputs were more negative affected by the increasing inside of Chinese import competition in comparison with their more productive counterparts. Moreover, even when the impact of Chinese competition lowers innovation for all firms, the magnitude of this effect is larger for low productivity than for high productivity firms. The results suggest that Chinese import competition, specially affects innovation inputs among initially less productive firms rather than innovation outputs inputs, since these types of firms in presence of import competition reduce their R&D investments, cut the number of workers in R&D activities and scaled back the specialized training investment.

On the other hand, panel D and E in table 13, present the results for initially more productive firms. We find that even though, more productive firms increased their innovation inputs and outputs indicators to cope with rising Chinese import competition, such efforts were not enough to overcome the average negative effect caused by tough competition from China, specially in the dimensions of R&D investment, specialized

[7] These categories can be also defined as: Low productivity (Q1), Low-middle productivity (Q2), Middle productivity (Q3), Middle-high productivity (Q4) and High Productivity (Q5)

training and patenting. However, the estimation results in columns 3 of panel D, indicate that middle-high productivity firms or those firms belonging to the Q4 group, responded to Chinese import competition by increasing the number of workers devoted to R&D activities. The coefficients of this relation suggest that one standard deviation increase in the Chinese import penetration rate is associated with a 4.8 percentage increase in the log of employees involve in the R&D activities. Moreover in column 5 of panel E, we find that firms at the highest productivity level, reacted to Chinese import competition by increasing the number of intellectual property right. In this sense, one standard deviation increase in the Chinese import penetration rate, increases the number of property right register by around 1 percentage points among highest productive manufacturing firms. Overall the negative impact of the Chinese import shock on innovation is magnified for low productivity firms, whereas it may positively affect innovation in high productivity firms.

Given these results, we consider that the differentiated respond between low and high productivity firms to import competition can only be explained by considering a non-monotonic relationship between innovation and competition. As Aghion et al. (2001) argued in their escape to competition effect modeled. In contrast, while a Schumpeterian argument may explain why low productivity firms innovate less it is inconsistent with high productivity firms innovating at the same time more. Subsequently the finding of more negative effects of Chinese import competition on initially less productive and just high productivity firms are able to slight respond to foreign competition are similar to those found by Aghion et al. (2018), arguing that since increasing competition reduces profits, discouraging innovation particularly for firms with low productivity. Moreover, such finding is in line with the evidence of industry leaders invest and innovate more in response to exogenous changes in Chinese competition. Gutiérrez and Philippon (2017).

We conclude that the finding that more productive firms innovate more in response to the China trade shock, specially by increasing the broad possibilities of intellectual property rights (not only patents), while the innovation indicators among less productive are more negative affected when facing Chinese competition. It means that import competition may extent the difference between high and low productivity firms because it leads to divergent response on innovation that amplifies the initial difference. This finding might suggest import competition triggers this heterogeneous and opposite response in term of productivity, leading to positive dynamic selection.

VI. Concluding Remarks

This paper studies the effects of China's growing import competition in on the innovation of manufacturing firm in a developing economy. For this purpose, we used firm-level data from surveys on Colombian firms, that allow us to distinguish two specific sort of innovation indicators: Innovation inputs, such as R&D spending, specialized training investment and workers engaged in R&D activities. And innovation outputs as the probability of holding a patent and the number of property right registers.

We find that excepting for the case of R&D workers, the average effect of Chinese import competition on the innovation inputs and outputs of Colombian manufacturing is negative and statistically significant. Moreover, initially less productive and less profitable firms, are more affected by Chinese imports competition, firm in these groups significantly reduced in greater extent their R&D and training investments, as well as the number of workers devoted to R&D activities.

Regarding to the difference in productivity levels, we find for all these innovation indicators that initially more productive firms are more likely to increase them as a response to the China import competition shock than the less productive firms where the innovation process is indeed more negative affected, being this difference across firm with diverse productivity, specially notable for R&D workers and Intellectual Property Right registrations.

The results presented in this paper complement the findings of the previous study about the effect of Chinese import competition on Colombian manufacturing firms. We can argue that greater Chinese import competition for manufacturing firms triggers a more general decline in their profitability, thereby reducing incentives to innovate and invest in R&D. The contraction along all margins of firm's innovation suggest that the primary response of firms to greater import competition is to scale back their innovation efforts. A results that closely related to the profitability mechanism of Dasgupta and Stiglitz (1980). Therefore to the question, Does Chinese import competition discourage innovation of manufacturing firms in developing economy as Colombia? we find evidence to answer yes it does, potentially trough the negative effect on firm's profitability.

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A. Tables and Figures

Table 1: *Distribution of Firms at EDITH and EAM by 2 Digit Industries*

Industry\Year	2004	2006	2008	2010	2012	Total Industry
Manufacture of food products and beverages	1,176	1,105	1,354	1,522	1,582	6739
Manufacture of tobacco products	4	3	4	6	4	21
Manufacture of textiles	302	294	327	374	401	1698
Manufacture of wearing apparel	706	613	763	939	1,004	4025
Tanning and dressing of leather; manufacture of luggage	281	267	357	390	388	1682
Manufacture of wood and of products of wood	363	333	472	509	557	2234
Manufacture of paper and paper products	196	188	219	150	158	911
Publishing, printing and reproduction of recorded media	127	122	209	358	315	1131
Manufacture of coke, refined petroleum products	25	28	29	35	55	172
Manufacture of chemicals and chemical products	483	519	656	734	765	3157
Manufacture of rubber and plastics products	483	511	607	696	741	3038
Manufacture of other non-metallic mineral products	276	282	339	388	430	1715
Manufacture of basic metals	114	114	130	164	174	696
Manufacture of fabricated metal products	389	396	542	665	731	2723
Manufacture of machinery and equipment	339	353	439	532	579	2,242
Manufacture of office and computing machinery	0	1	0	11	10	22
Manufacture of electrical machinery and apparatus	132	133	153	175	183	776
Manufacture of radio, television and communication equipment	14	11	14	20	11	70
Manufacture of medical and optical instruments, watches	41	48	61	76	92	318
Manufacture of motor vehicles	143	163	189	191	206	892
Manufacture of other transport equipment	33	39	47	56	53	228
Furniture and Others	478	502	755	656	701	3092
Total	6105	6025	7665	8647	9140	37582

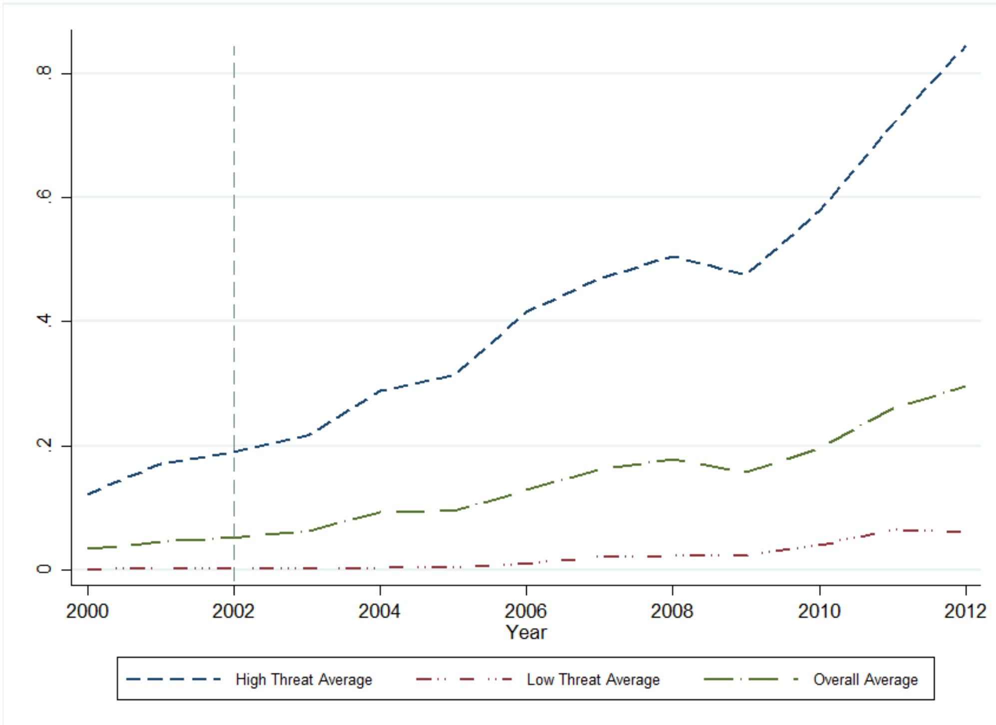
Authors' own calculation, data comes from *UNCOMTRADE. Survey of Development and Technological Innovation for Colombian Manufacturing firms. EDITH. Colombian Annual Manufacturing Survey, EAM.* Both reported by the Colombian Bureau of Statistics *Departamento Administrativo Nacional de Estadistica, DANE*

Table 2: *Descriptive Statistics, Innovation Inputs and Outputs. 2004-2012*

	2004				2012			
Variables	**Obs**	**Mean**	**Std. Dev.**	**Max**	**Obs**	**Mean**	**Std. Dev.**	**Max**
Workers	5,898	43.65683	83.14919	1340	8,962	38.4801	79.9406	1160
Total Sales	5,898	1613939	7081426	2.58e+08	8,962	1561318	1.06e+07	6.19e+08
Invest Training	5,898	1420.736	9198.686	403301.4	8,962	165.384	1618.101	82084.95
R&D Investment	5,898	2151.583	23514.93	736980.7	8,962	4349.96	118506.5	6245981
R&D Workers	6,105	2.588698	12.65631	323	9,140	2.5533	10.1532	207
Property Rights	6,105	.4219492	1.43428	28	9,140	1.6950	69.9551	5122
Patents	6,105	.0214578	.1449166	1	9,140	.0076586	.0871827	1
IMPCH	6,104	.0480585	.087115	.648559	9,140	.1938207	.2007104	.985323

Note: Values are expressed in thousand 2005 Colombians peso. The variables: Investment in specialized training, R&D investments, Total number of workers devoted to R&D activities, Total number of workers are directly reported by the firm to the EDITH survey. The variable property Rights included the total number of intellectual property rights of any type. (Software, Industrial Designs, Copyright, Patent and Utility Models. Trademark are excluded). The patent variable is an dummy related whether the firm hold a patent register or not. The source of the data is EDITH Survey (DANE). Authors' calculation.

Figure 1: *Chinese Import Penetration Rate in Colombia*



Source: Author's own calculation. Data comes from UNCOMTRADE

Table 3: *The Effect of Chinese Import Competition on Specialized Training Investment*

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	OLS	OLS	IV	IV	IV
Dependent Variable	training	training	training	training	training	training
IMPCH No controls		-2.396***			-18.70***	
		(0.082)			(1.479)	
IMPCH	-2.673***	-2.372***	-2.356***	-23.63***	-23.48***	-23.28***
	(0.128)	(0.124)	(0.122)	(2.212)	(2.220)	(2.248)
IMP. No China	0.571***	0.517***	0.437***	-5.145***	-5.115***	-5.069***
	(0.068)	(0.067)	(0.065)	(1.079)	(1.077)	(1.080)
Multi-plant	1.305***	1.170***	1.081***	-0.458	-0.441	-0.424
	(0.180)	(0.178)	(0.176)	(0.449)	(0.465)	(0.463)
Bogota	-0.0240	0.048	0.071*	0.650**	0.644**	0.638**
	(0.039)	(0.038)	(0.037)	(0.321)	(0.320)	(0.320)
Log Gross Inv.	0.152***	0.135***	0.087***	-0.021	-0.021	-0.019
	(0.009)	(0.008)	(0.009)	(0.016)	(0.016)	(0.015)
Exit		-0.134*	-0.161**		-0.160	-0.159
		(0.077)	(0.078)		(0.209)	(0.208)
Entry		0.371***	0.341***		0.349**	0.338**
		(0.065)	(0.065)		(0.144)	(0.144)
Age		0.111***	0.097***		0.030	0.028
		(0.005)	(0.004)		(0.109)	(0.108)
Export			0.180***			-0.199**
			(0.043)			(0.087)
Importer			0.783***			0.127
			(0.053)			(0.091)
First Stage						
log IV				0.025***	0.026***	0.026***
				(0.002)	(0.002)	(0.002)
Kleibergen-Paap F-test				141.5	140	137.3
Year and Firm Fixed Effect	✓	✓	✓	✓	✓	✓
Observations	21,488	21,488	21,488	18,734	18,734	18,734
Number of firm_ID	8,549	8,549	8,549	5,719	5,719	5,719

Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3.

Table 4: *The Effect of Chinese Import Competition on Specialized Training Investment among Heterogeneous Firms at the Initial Period.*

	Sales		Total Workers		Profitability		Skill Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)
IMPCH	-1.912***	-2.976***	-1.848***	-3.005***	-2.614***	-1.732***	-2.351***	-2.903***
	(0.116)	(0.174)	(0.118)	(0.171)	(0.160)	(0.149)	(0.130)	(0.175)
High Sales*IMPCH	-1.531***							
	(0.406)							
Low Sales*IMPCH		1.809***						
		(0.209)						
High Workers*IMPCH			-2.359***					
			(0.352)					
Low Workers*IMPCH				1.823***				
				(0.208)				
High Profit*IMPCH					1.082***			
					(0.255)			
Low Profit*IMPCH						-1.641***		
						(0.272)		
High Skill Intensity*IMPCH							-0.0446	
							(0.319)	
Low Skill Intensity*IMPCH								1.489***
								(0.217)
Year and Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	21,480	21,480	21,488	21,488	19,041	19,041	21,480	21,480
Number of firm ID	8,547	8,547	8,549	8,549	7,475	7,475	8,546	8,546

Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3.

Table 5: *The Impact of Chinese Competition on R&D Investment of Manufacturing Firms*

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	OLS	OLS	IV	IV	IV
Dependent Variable	Log R&D	Log R&D	Log R&D	Log R&D	Log R&D	Log R&D
IMPCH No controls		-1.691***			-9.349***	
		(0.098)			(1.512)	
IMPCH	-1.721***	-1.514***	-1.542***	-14.90***	-14.67***	-14.18***
	(0.160)	(0.159)	(0.157)	(2.535)	(2.540)	(2.571)
IMP. No China	0.635***	0.601***	0.533***	-3.271***	-3.213***	-3.135***
	(0.081)	(0.080)	(0.078)	(1.083)	(1.081)	(1.080)
Log Gross Inv.	0.162***	0.149***	0.105***	0.002	-0.001	-0.008
	(0.011)	(0.011)	(0.011)	(0.017)	(0.017)	(0.017)
Exit		-0.370***	-0.408***		-0.426**	-0.430**
		(0.096)	(0.096)		(0.213)	(0.212)
Entry		0.333***	0.300***		0.295*	0.283*
		(0.095)	(0.095)		(0.151)	(0.150)
Age		0.092***	0.077***		0.130	0.117
		(0.006)	(0.006)		(0.135)	(0.135)
Importer			0.790***			0.327***
			(0.064)			(0.102)
Export			0.263***			-0.061
			(0.055)			(0.096)
Log IV				0.025***	0.026***	0.026***
				(0.002)	(0.002)	(0.002)
Kleibergen-Paap Wald F-test				141.5	140	137.3
Year and Firms Effects	✓	✓	✓	✓	✓	✓
Observations	19,548	19,548	19,548	17,022	17,022	17,022
Number of firm_ID	7,816	7,816	7,816	5,218	5,218	5,218

Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 6: *The Effect of Chinese Import Competition on R&D Investment among Heterogeneous Firms at the Initial Period.*

	Sales		Total Workers		Profitability		Skill Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)
IMPCH	-1.338***	-1.881***	-1.289***	-1.919***	-1.620***	-1.085***	-1.493***	-1.824***
	(0.128)	(0.204)	(0.131)	(0.202)	(0.186)	(0.179)	(0.155)	(0.207)
High Sales*IMPCH	-0.0130							
	(0.525)							
Low Sales*IMPCH		1.273***						
		(0.248)						
High Workers*IMPCH			-0.989**					
			(0.446)					
Low Workers*IMPCH				1.272***				
				(0.244)				
High Profit*IMPCH					0.526			
					(0.321)			
Low Profit*IMPCH						-1.063***		
						(0.319)		
High Skill Intensity*IMPCH							0.0340	
							(0.375)	
Low Skill Intensity*IMPCH								0.977***
								(0.253)
Year and Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	18,727	18,727	18,734	18,734	16,702	16,702	18,727	18,727
Number of firm_ID	5,718	5,718	5,719	5,719	5,062	5,062	5,717	5,717

Note: Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 7: *The Impact of Chinese import Competition on Number of Workers devoted to R&D Activities*

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	OLS	OLS	IV	IV	IV
Dependent Variable	lRD_workers	lRD_workers	lRD_workers	lRD_workers	lRD_workers	lRD_workers
IMPCH No controls		-0.365***			-0.287	
		(0.038)			(0.478)	
IMPCH	-0.160***	-0.129***	-0.159***	-0.711	-0.601	-0.537
	(0.042)	(0.042)	(0.042)	(0.561)	(0.573)	(0.578)
IMP. No China	0.060**	0.049*	0.025	-0.146	-0.134	-0.125
	(0.027)	(0.027)	(0.026)	(0.298)	(0.299)	(0.300)
Multi-plant	0.860***	0.825***	0.797***	0.281*	0.296*	0.300*
	(0.073)	(0.072)	(0.072)	(0.149)	(0.159)	(0.159)
Bogota	-0.043**	-0.026	-0.016	0.019	0.021	0.020
	(0.016)	(0.016)	(0.016)	(0.101)	(0.102)	(0.102)
Exit		-0.197***	-0.205***		-0.253***	-0.253***
		(0.0329)	(0.033)		(0.057)	(0.057)
Entry		0.027	0.021		-0.007	-0.002
		(0.036)	(0.035)		(0.045)	(0.045)
Age		0.025***	0.020***		0.008	0.008
		(0.002)	(0.002)		(0.029)	(0.029)
Export			0.127***			-0.041
			(0.018)			(0.029)
Importer			0.174***			0.022
			(0.021)			(0.030)
First Stage						
Log IV				0.025***	0.026***	0.026***
				(0.002)	(0.002)	(0.002)
Kleibergen-Paap F-test				141.5	140	137.3
Year and Firms Fixed Effects	✓	✓	✓	✓	✓	✓
Observations	21,488	21,488	21,488	18,734	18,734	18,734
Number of firm_ID	8,549	8,549	8,549	5,719	5,719	5,719

The dependent variable is the logarithm of workers in R&D activities, directly reported by the firms. Robust standard errors in parentheses, clustered by 4 digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 8: *The Effect of Chinese Import Competition on Worker Devoted to R&D Activities Among Heterogeneous Firms at The Initial Period.*

	Sales		Total Workers		Profitability		Skill Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)
IMPCH	0.00424	-0.181**	0.0361	-0.164**	-0.140**	0.0228	-0.0901	-0.166**
	(0.0513)	(0.0742)	(0.0519)	(0.0736)	(0.0674)	(0.0686)	(0.0586)	(0.0720)
High Sales*IMPCH	-0.271							
	(0.182)							
Low Sales*IMPCH		0.305***						
		(0.0945)						
High Workers*IMPCH			-0.681***					
			(0.160)					
Low Workers*IMPCH				0.187**				
				(0.0937)				
High Profit*IMPCH					0.122			
					(0.125)			
Low Profit*IMPCH						-0.344***		
						(0.117)		
High Skill Intensity*IMPCH							-0.0696	
							(0.135)	
Low Skill Intensity*IMPCH								0.201**
								(0.0994)
Year and Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	17,015	17,015	17,022	17,022	16,416	16,416	17,017	17,017
Number of firm_ID	5,217	5,217	5,218	5,218	5,003	5,003	5,216	5,216

Note: The dependent variable is the logarithm of workers in R&D activities, directly reported by the firms. Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 9: *The Impact of Chinese import Competition on Patents*

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	Probit	Probit	Probit	IV(Probit)	IV(Probit)	IV(Probit)
Dependent Variable	Patent	Patent	Patent	Patent	Patent	Patent
IMPCH No controls		-0.873***			-1.359***	
		(0.172)			(0.282)	
IMPCH	-0.795***	-0.418**	-0.498**	-1.137***	-1.401***	-1.756***
	(0.190)	(0.208)	(0.215)	(0.348)	(0.417)	(0.425)
IMP. No China	0.242***	0.194***	0.184***	0.182***	0.120*	0.085
	(0.055)	(0.066)	(0.068)	(0.062)	(0.070)	(0.072)
Bogota	0.076*	0.083*	0.0968*	0.083**	0.095*	0.114**
	(0.041)	(0.050)	(0.050)	(0.041)	(0.049)	(0.049)
Log Gross Inv.		0.0237*	0.0170		0.0225	0.015
		(0.014)	(0.014)		(0.014)	(0.014)
Log Average Wage		0.136***	0.084		0.135***	0.073
		(0.050)	(0.054)		(0.049)	(0.053)
Log Workers		0.086***	0.057**		0.0812***	0.048*
		(0.025)	(0.026)		(0.0254)	(0.026)
Exit		-0.242	-0.241		-0.263	-0.265
		(0.256)	(0.256)		(0.255)	(0.254)
Entry		0.242*	0.226*		0.226*	0.202
		(0.137)	(0.136)		(0.136)	(0.134)
Age		0.024***	0.021**		0.020**	0.016*
		(0.008)	(0.009)		(0.008)	(0.009)
Importer			0.109*			0.107*
			(0.059)			(0.058)
Export			0.154***			0.197***
			(0.057)			(0.059)
Log IV				0.027***	0.028***	0.027***
				(0.003)	(0.005)	(0.005)
Year and Firm Fixed Effects	✓	✓	✓	✓	✓	✓
Observations	21,488	21,488	21,488	18,734	18,734	18,734
Number of firm_ID	8,549	8,549	8,549	5,719	5,719	5,719

Dependent variable is a dummy variable indicating whether a firm holds a patent register or not. Robust standard errors in parentheses, clustered by 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out.

Table 10: *The Effect of Chinese Import Competition on The Probability of Holding a Patent Among Heterogeneous Firms at The Initial Period.*

	Sales		Total Workers		Profitability		Skill Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)
IMPCH	-0.888***	-0.214	-0.685**	-0.258	-0.346	-0.979***	-0.638***	-0.222
	(0.301)	(0.203)	(0.280)	(0.202)	(0.214)	(0.365)	(0.240)	(0.210)
High Sales*IMPCH	1.313***							
	(0.325)							
Low Sales*IMPCH		-0.938*						
		(0.548)						
High Workers*IMPCH			0.727**					
			(0.310)					
Low Workers*IMPCH				-0.687				
				(0.499)				
High Profit*IMPCH					-1.275*			
					(0.751)			
Low Profit*IMPCH						0.858**		
						(0.372)		
High Skill Intensity*IMPCH							0.783**	
							(0.318)	
Low Skill Intensity*IMPCH								-0.652
								(0.397)
Year and Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	21,480	21,480	21,488	21,488	19,041	19,041	21,480	21,480

Note: Dependent variable is a dummy variable indicating whether a firm holds a patent register or not. Robust standard errors in parentheses, clustered by 4 digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 11: *The Impact of Chinese import Competition on Number Property Rights Registration*

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	OLS	OLS	OLS	IV	IV	IV
Dependent Variable	Prop. Rights	Prop. Rights	Prop. Rights	Prop. Rights	Prop. Rights	Prop. Rights
IMPCH No controls		-0.167***			-0.629***	
		(0.015)			(0.209)	
IMPCH	-0.191***	-0.178***	-0.185***	-0.790***	-0.789***	-0.770***
	(0.022)	(0.022)	(0.023)	(0.259)	(0.261)	(0.264)
IMP. No China	0.0105	0.008	0.004	-0.118	-0.118	-0.114
	(0.012)	(0.012)	(0.012)	(0.126)	(0.126)	(0.127)
multi-plant	0.148***	0.140***	0.135***	-0.042	-0.038	-0.037
	(0.042)	(0.042)	(0.041)	(0.067)	(0.066)	(0.066)
Bogota	0.021***	0.025***	0.027***	0.032	0.030	0.029
	(0.007)	(0.007)	(0.007)	(0.0542)	(0.054)	(0.054)
Log Gross Inv.	0.011***	0.009***	0.006***	-0.0015	-4.27e-05	1.38e-06
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Exit		0.006	0.005		0.039	0.039
		(0.023)	(0.023)		(0.046)	(0.045)
Entry		0.026	0.025		0.0299	0.029
		(0.017)	(0.017)		(0.024)	(0.024)
Age		0.006***	0.005***		0.005	0.005
		(0.009)	(0.001)		(0.017)	(0.017)
Export			0.0271***			-0.015
			(0.008)			(0.013)
Importer			0.033***			0.013
			(0.009)			(0.013)
First Stage						
Log IV				0.025***	0.026***	0.026***
				(0.002)	(0.002)	(0.002)
Kleibergen-Paap F-test				141.5	140	137.3
Year and Firm Fixed Effects	✓	✓	✓	✓	✓	✓
Observations	21,487	21,487	21,487	18,733	18,733	18,733
Number of firm_ID	8,549	8,549	8,549	5,719	5,719	5,719

The dependent variable is the logarithm of property rights, in this variable are included property rights related to: Softwares, Industrial Designs, Copyrights, Patent and Utility Models. Trademark rights are excluded. Robust standard errors in parentheses, clustered by 4 digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 12: *The Effect of Chinese Import Competition on The Number of Property Right Registrations among Heterogeneous Firms at The Initial Period.*

	Sales		Total Workers		Profitability		Skill Intensity	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)	High (Q5)	Low (Q2,Q1)
IMPCH	-0.160***	-0.231***	-0.168***	-0.234***	-0.208***	-0.148***	-0.204***	-0.212***
	(0.024)	(0.033)	(0.023)	(0.033)	(0.030)	(0.022)	(0.027)	(0.032)
High Sales*IMPCH	-0.110							
	(0.0723)							
Low Sales*IMPCH		0.129***						
		(0.037)						
High Workers*IMPCH			-0.107					
			(0.066)					
Low Workers*IMPCH				0.131***				
				(0.036)				
High Profit*IMPCH					0.056			
					(0.039)			
Low Profit*IMPCH						-0.118**		
						(0.048)		
High Skill Intensity*IMPCH							0.043	
							(0.054)	
Low Skill Intensity*IMPCH								0.054
								(0.039)
Year and Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	19,539	19,539	19,547	19,547	18,791	18,791	19,542	19,542
Number of plant_id	7,814	7,814	7,816	7,816	7,449	7,449	7,814	7,814

Note: The dependent variable is the logarithm of property rights, in this variable are included property rights related to: Softwares, Industrial Designs, Copyrights, Patent and Utility Models. Trademark rights are excluded. Robust standard errors in parentheses, clustered by 4 digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

Table 13: *The Effects of Chinese Import Competition on Innovation Indicators, Considering Firms Heterogeneity by Initial Productivity level*

Quantiles	(1) R&D Inv.	(3) R&D Workers	(4) Training Inv.	(5) Prop. Right	(6) Patents
			Panel A		
IMPCH	-1.331***	-0.072	-2.285***	-0.180***	-0.390*
	(0.169)	(0.063)	(0.143)	(0.026)	(0.206)
Q1_TFP * IMPCH	-0.675***	-0.400***	-0.283	0.005	-0.035
	(0.237)	(0.098)	(0.197)	(0.029)	(0.477)
			Panel B		
IMPCH	-1.357***	-0.092	-2.260***	-0.176***	-0.258
	(0.170)	(0.064)	(0.144)	(0.027)	(0.205)
Q2_TFP * IMPCH	-0.421	-0.225**	-0.345*	-0.0138	-1.058*
	(0.258)	(0.093)	(0.207)	(0.026)	(0.548)
			Panel C		
IMPCH	-1.420***	-0.124*	-2.390***	-0.179***	-0.441**
	(0.172)	(0.064)	(0.142)	(0.027)	(0.220)
Q3_TFP * IMPCH	-0.109	-0.065	0.254	0.001	0.178
	(0.245)	(0.095)	(0.215)	(0.029)	(0.357)
			Panel D		
IMPCH	-1.710***	-0.292***	-2.485***	-0.208***	-0.552**
	(0.160)	(0.057)	(0.130)	(0.024)	(0.251)
Q4_TFP * IMPCH	1.277***	0.732***	0.746***	0.139***	0.548*
	(0.312)	(0.122)	(0.251)	(0.043)	(0.303)
			Panel E		
IMPCH	-1.393***	-0.109*	-2.195***	-0.137***	-0.386*
	(0.172)	(0.0636)	(0.147)	(0.024)	(0.219)
Q5_TFP * IMPCH	0.265	0.156	0.720**	0.223***	0.064
	(0.387)	(0.145)	(0.323)	(0.066)	(0.377)
Year and Firm FE	✓	✓	✓	✓	✓
Observations	19,546	19,546	19,546	19,545	19,545
Number of firm ID	7,815	7,815	7,815	7,815	7,815

Note: Robust standard errors in parentheses, clustered on 4-digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. Includes the full set of controls from column 3 in table 3

B. Appendix

i. Data

Innovation Firm-level Data

The source of the firms-level innovation related indicator is the Survey of Development and Technological Innovation in the manufacturing sector (EDIT), conducted by the Colombian Bureau of Statistics (Departamento Administrativo Nacional de Estadistica, DANE). The aim of this survey is to characterize technological dynamics and the activities related to innovation and technological development of manufacturing firms in Colombia. By reporting variables that directly and indirectly affect the creation of new products, processes, marketing techniques and forms of organization, or their substantial improvement, as well as, its impact on the economy, for Colombian manufacturing firms having establishments with 10 or more employees and are included in the register of firms of the Manufacturing Annual Survey (EAM). EDIT design preserves a basic international theoretical framework on the design, application and interpretation of national surveys on innovation, it incorporates most of the methodological approach followed by the Organization of Cooperation and Economic Development (OECD), in particular the Oslo Manual, and by the Latin American Network of Indicators of Science and Technology (RICYT), compiled in the Bogota Manual.

Firm-level Data

The Development and Technological Innovation Industrial Survey (EDIT) was matched to The Annual Manufacturing Survey (AMS) to obtain detailed information on innovation and technological activities conducted by manufacturing firms in Colombia, in order to study the impact of Chinese import competition on innovation inputs and outputs of manufacturing firms. This process was possible due to fact that firm identifiers in both surveys are the same. The (AMS), is an unbalanced panel that registers information on all manufacturing establishments with 10 or more employees. The aim of AMS is to obtain basic information from the industrial sector, which would provide facts about its structure, characteristics and evolution. The AMS provides the annual information about the behavior, changes and evolution of the manufacturing industry in Colombia. This information is obtained through a number of establishments, employed personnel, accrued remunerations (wages, salaries and social contributions), gross and industrial output, intermediate consumption, value added, gross and net investment, electricity consumed, fixed assets values, amongst others. The (AMS) is conducted by the Colombian Bureau of Statistics (Departamento Administrativo Nacional de Estadistica, DANE).

Trade Data

The trade data used to compute the import competition measure were taken from the UNCOMTRADE database, initially the trade data was downloaded as six-digit Harmonized System (HS) which is product-level data and then was converted into its ISIC rev.3 version, which is 4 digit disaggregated industry-level data, by using the official correspondence table from HS96 to ISIC rev.3 available at the United Nations website. We proceed in this way, because UNCOMTRADE database is the only source of disaggregate trade data for Colombia, specifically was the only way to get four-digit disaggregated trade industry level data.

ii. Additional Robustness Checks

In this section, this study test whether the results describing the effect of Chinese import competition on innovation inputs and outcomes of manufacturing firms, are sensible to using a different variable as instrument. Since the aim of this paper is to find a casual effect of Chinese import competition on the innovation indicators of manufacturing firms, to address the endogenity problem is a fundamental strategy to obtain such unbiased estimations of this effect. The type of endogeneity presented in the main regression equation (2), is associate with X_{ijt} being correlated with ϵ_{ijt}. It is possible that some of the explanatory variables may be correlated with the error term, as we argued in the methodological section, is likely that the Chinese Import competition measure is correlated to unobservable technology and demand shocks. Moreover, such correlation may be stronger for products where both China's and Colombia's comparative advantages are high, hence it might bias the real competition effect.

To tackle this problem, we would need to find an instrumental variable Z_{jt}, correlated with $IMPCH_{jt}$ and uncorrelated with ϵ_{ijt}. The usual identification strategy is that an instrument must be a variable that does not appear directly as a regressor in the model, but is highly correlated with the endogenous variables. Then, the instrumental variable estimator is consistent, if is proved that the instrument is uncorrelated with the error term.

In that sense the additional instrumental variable strategy based on China joining the WTO and the initial conditions. Since we are interested in capturing accelerating Chinese imports triggered by the WTO accession, the instruments should capture this 'China' driven component unrelated to the Colombian imports demand factors. Moreover, since sectors in which China was already exporting in 1999 such as textiles, furniture and toys are likely to be those where China had a comparative advantage and are also the sectors which experienced much more rapid increase in import penetration in the subsequent years. Consequently, high exposure to Chinese imports prior to the China accession to the WTO as for instance in 1999 can be used as a potential instrument for subsequent Chinese import growth.

Therefore, the new instrument considered for the Chinese share of import penetration rate is the exogenous overall growth of Chinese imports, calculated excluding the Colombian imports, interacted with the 1999 Chinese import share in the corresponding 4 digit ISIC industry in Colombia. $IV_2 = (CH^x_{jt} - CHCOL^x_{jt}) * IMCH_{j99}$. By doing so, we get the cross-industry variation in the degree of Chinese import competition.

To be a good instrument this new variable must meet the exogenity and relevance conditions. We argue that, the worldwide Chinese imports must be exogenous from the perspective of Colombian manufacturing plants as it is driven just by China. Furthermore the instrument is intuitively relevant given the correlation of China's export expansion in industries where it has already a comparative advantage, as is suggested by Amiti and Freund (2008)[8].

According to the estimations for new instrument in table 14, the results obtained using this new identification approach are similar to those found using the initial instrument, indicating the robustness of the findings of this paper and the robustness of the data generating process, under different instruments. Moreover, regarding to the relevance and validity of instruments, the underidentification test, Kleibergen-Paap LM statistic, rejected the null hypothesis, indicating that the matrix is full column rank and the model is identified. Moreover, all the coefficient at the first stage results are significant suggesting a correlation between the new instrument and the measure of Chinese import competition.

[8] They argued that three quarters of the aggregate growth of Chinese imports was from the expansion of existing products rather than from adding new products.

Table 14: *Robustness Check: Results with Alternative Instrument*

	(1)	(2)	(3)	(4)	(5)
Specification	IV	IV	IV	IV	IV(Probit)
Models	R&D workers	Training Inv.	R&D Inv.	Property Rights	Patents
			Panel A: Second Stage Results		
IMPCH No controls	-0.543	-15.45***	-8.356***	-0.582***	-1.895*
	(0.444)	(1.267)	(1.375)	(0.193)	(0.0542)
Firms Controls	-0.673	-21.82***	-12.413***	-0.752***	-1.211**
	(0.643)	(2.212)	(2.049)	(0.259)	(0.0832)
Export and Importer Controls	-0.570	-16.36***	-9.116***	-0.690**	-1.978***
	(0.679)	(1.322)	(2.048)	(0.295)	(0.0816)
Entry-Exit Controls	-0.532	-16.74***	-9.710***	-0.589**	-1.303***
	(0.835)	(2.318)	(2.540)	(0.365)	(0.102)
Firm Fixed Effects	✓	✓	✓	✓	✓
Year Fixed Effects	✓	✓	✓	✓	✓
Number of Firms	5,719	5,719	5,218	5,719	5,719
Number of Observations	18,734	18,734	17,022	18,733	18,734

		Panel B: First Stage Results		
Models	IMPCH No controls	Firms Controls	(Export and Importer Controls)	Entry-Exit Controls
$IV_2 = IMCH_{j99} * (CH^x_{jt} - CHCOL^x_{jt})$	0.034***	0.036***	0.034***	0.033***
	(0.003)	(0.004)	(0.004)	(0.013)
Kleibergen-Paap Wald F-test	115	108	117	.

Robust standard errors in parentheses, clustered by 4 digit ISIC industries. ***, ** and * indicate significance at 1%, 5% and 10% levels respectively. By Industry by year fixed effects are partial led out. In the model with Firm controls are included the variables: A dummy if the firms is multi plant, proxy for firms' Age, a dummy whether the firm is located in Bogota and firms' gross investment. The model with export and importer refers includes in addition to the above mentioned firms' controls, a dummy variables whether the firms exports and imports, respectively. Finally, the Entry-Exit model includes in addition to the two above mentioned models, two dummy variables to control for firms' entry and exit in the market.

iii. Additional Analysis, Descriptive Statistics and Calculations

Figure 2: *Chinese Import Penetration Rate and R&D Workers by Industry*

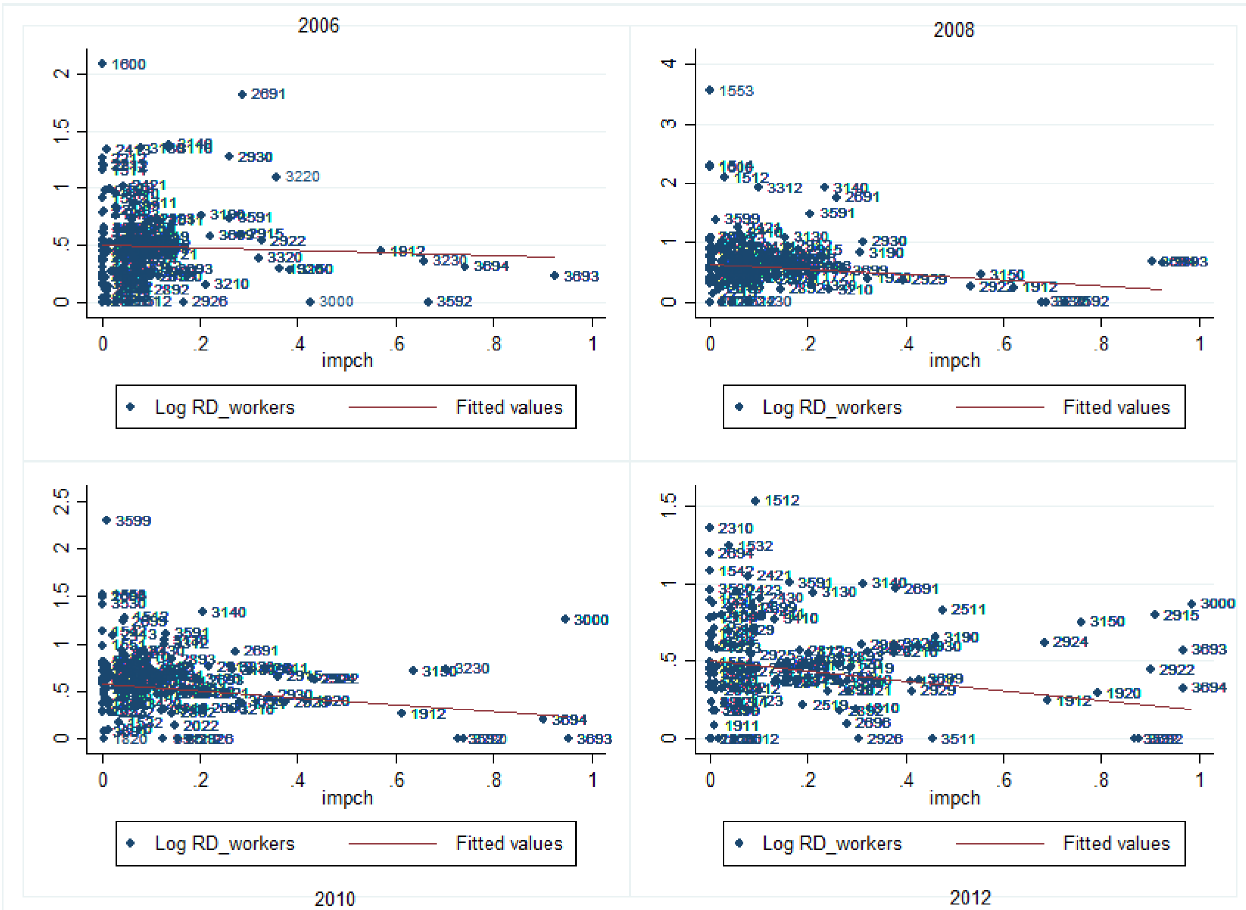
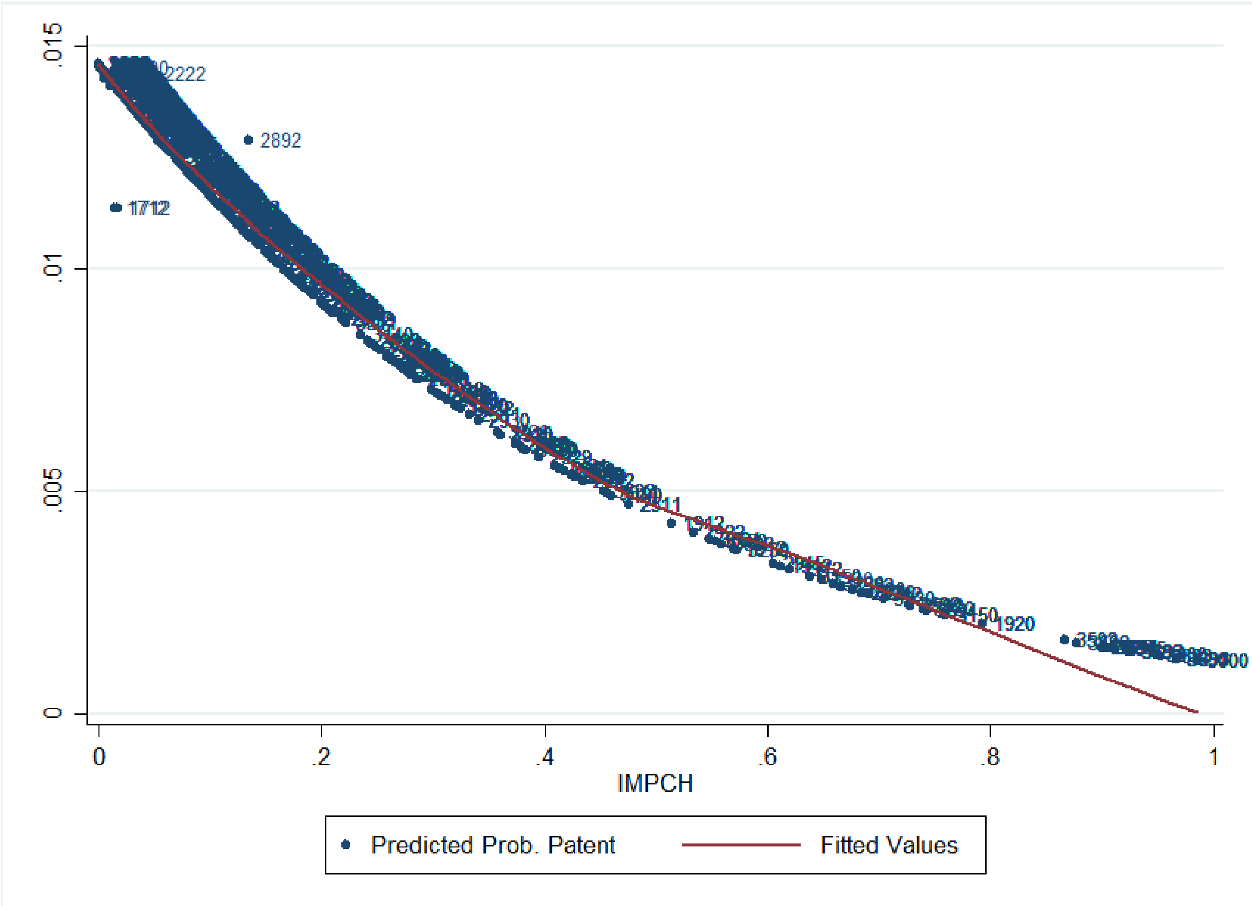


Figure 3: *Chinese Import Penetration Rate and Training Investment by Industry*

Figure 4: *Chinese Import Penetration Rate and R&D Investment by Industry*

Figure 5: *Chinese Import Penetration Rate and the Predicted Probability of Patenting*



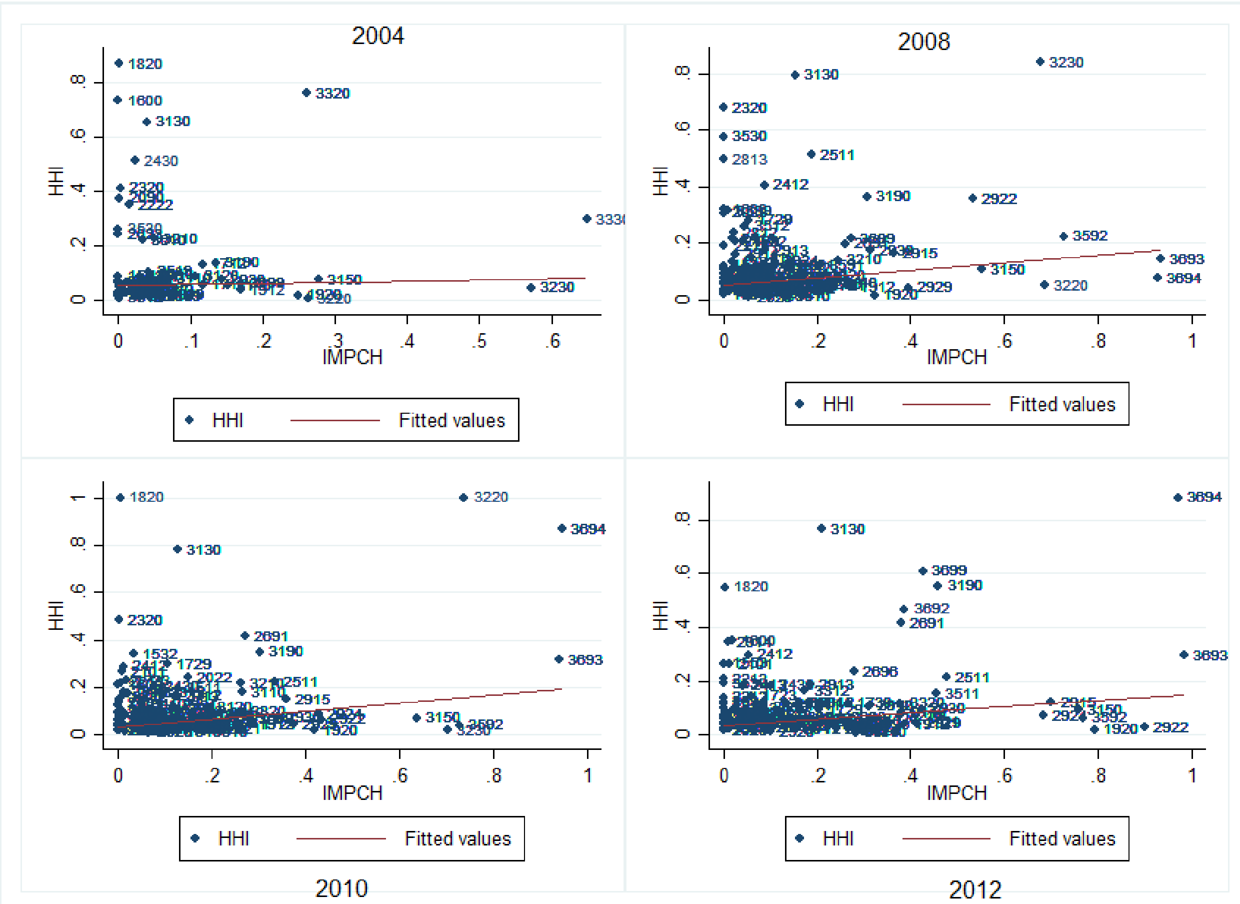
Industry Concentration in Colombia and Chinese Import Competition

Measure of Industry Concentration: HHI Index.

The Herfindhal-Hirschman index, was calculated as:

$$HHI = \frac{\sum_{i=1}^{n}(S_i)^2 - \frac{1}{n}}{1 - \frac{1}{n}} \qquad S_i = \frac{x_i}{\sum_{i=1}^{n} x_i} \tag{4}$$

Figure 6: *Chinese Import Penetration rate 4 Digit Industrial Output Concentration Index in Colombia.*



Source: Author's own calculation. Data comes from UNCOMTRADE